MINING METHODS AND COSTS, BAGUIO GOLD MINE, BAGUIO GOLD MINING CO., BAGUIO, LUZON, PHILIPPINE ISLANDS

BY A. A. BAKEWELL, JR.

* * * * * * * * * **Information Circular 7903**

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FOREWORD

The Bureau of Mines is pleased to present this report as an excellent description of a gold-mining operation in the Philippine Islands. It was written for the Bureau by A. A. Bakewell, general manager, Baguio Gold Mining Co., Luzon, and becomes part of the Bureau's series describing mining methods, practices, and costs at representative operations. This publication is the first in the series to cover a foreign mining activity.

Paul T. Allsman,
Chief mining engineer,
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Washington, D. C.

CONTENTS

Page

Foreword
Introduction and summary.................................... 1
Location and physical features.............................. 1
History and production...................................... 2
Physical characteristics of ore and enclosing rocks......... 4
Methods of prospecting and exploration...................... 5
Sampling and estimating reserves............................ 6
Methods of development and mining........................... 6
    Development... 6
    Mining.. 16
    Underground transportation.............................. 16
    Auxiliary operations.................................... 25
Equipment... 28
Percentage extraction and production rates.................. 29
Comparison of methods used in district...................... 30
Mine ventilation.. 30
Mine drainage... 30
Milling... 31
Incentive wage system....................................... 31
Safety methods.. 37
Mining and milling costs.................................... 38

ILLUSTRATIONS

Fig.

1. Headframe, mill, and auxiliary buildings............. 2
2. General map of Philippine Islands.................... 3
3. Plant layout... 8
4. Section showing underground workings................. 9
5. San Pablo shaft set.................................. 10
6. Map showing underground workings..................... 11
7. San Pablo shaft drill round.......................... 12
8. Standard drift set................................... 13
9. Standard drift round................................. 13
10. Company-built 1-1/2-ton side-dump mine car.......... 14
11. Company-built 1/2-ton stope car..................... 14
12. Advancing flat raise with scraper................... 15
13. Advancing flat raise with 1/2-ton boxcar............ 15
14. Cut-and-fill stoping with stulls.................... 17
15. Cut-and-fill stoping with square sets............... 17

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ILLUSTRATIONS (Con.)

Fig. **Page**

16. Standard square set.................................. 18
17. Standard umbrella stull set........................... 19
18. Shop-assembled 5-ton diesel locomotive............... 20
19. Shop-built exhaust scrubber for diesel locomotive.... 21
20. Ore-pocket arrangement................................ 22
21. Hoist, headframe, and bin arrangement................ 23
22. Skip and cage arrangement............................. 24
23. Tool for regrooving head sheave....................... 25
24. Arc gate for permanent chutes and pockets............ 26
25. Inclined-winze dumping arrangement................... 27
26. Schematic drawing, mill flowsheet.................... 32
27. Safety department inspector's shift report........... 39
28. Safety engineer's daily report....................... 40

TABLES

1. Annual production, Baguio Gold Mining Co............. 4
2. Mining efficiencies, Baguio Gold Mining Co........... 30
3. Schedule of contract prices, Baguio Gold Mining Co... 33
4. Number of employees, Baguio Gold Mining Co........... 37
5. Accident statistics, Baguio Gold Mining Co........... 38
6. Mill statistics, Baguio Gold Mining Co............... 41
7. Average consumption of mill supplies, Baguio Gold Mining Co... 41
8. Average consumption of refinery supplies, Baguio Gold Mining Co... 41
9. Cost statistics, pesos per ton milled................ 42
10. Tons mined, man-shifts, and tons mined per man-shift... 42
11. Average consumption of mine supplies................. 43
12. Average stoping (including distributive and service accounts) and development costs.................... 44
13. Average mining cost - stoping........................ 44
14. Average mining cost - raising........................ 45
15. Average mining cost - drift and crosscut............. 45
16. Average mining cost - sublevels...................... 46
17. Direct mining costs - diamond drilling............... 46
18. Summation of costs per ton of ore mined.............. 47

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MINING METHODS AND COSTS, BAGUIO GOLD MINE, BAGUIO GOLD MINING CO., BAGUIO, LUZON, PHILIPPINE ISLANDS[1]

by

A. A. Bakewell, Jr.[2]

INTRODUCTION AND SUMMARY

This information circular, which describes mining methods and practices at the Baguio Gold Mining Co., Philippine Islands, is one of a series being prepared by the Bureau of Mines on mining methods, practices, and costs.

Since January 1952, Baguio Gold Mining Co. has operated its rehabilitated mine and mill in the Baguio district. Postwar labor and supply costs are three or four times prewar costs, whereas ore tenor and tonnage are about the same. Ore reserves remain approximately the same, but deeper and more spreadout operations add to increasing costs. Recently the company has acquired an adjoining property, which may lengthen its life substantially.

Costs and general operations are more or less typical of the district, which includes three other active gold mines. Gold ore mined in the district totals approximately 4,300 tons per day.

LOCATION AND PHYSICAL FEATURES

The Baguio gold mine is in the Mountain Province, Luzon, Philippine Islands, adjacent to the eastern boundary of Baguio, a modern city of 30,000 and the principal summer resort of the Philippines. The climate is cool and healthy throughout the year, having mean annual temperature of 65° F. The dry season lasts from November to June and the rainy season from July to October. Precipitation during the rainy season is heavy but irregular (99.51 inches in 1954, 86.02 inches in 1955, and 135.92 inches in 1956). Severe storms occur (the word "baguio" means typhoon), but the tendency in recent years is toward a milder climate the year round.

The elevation of the city of Baguio is 4,500 feet, and the millsite is 500 feet or more below the city on the edge of the Antamok River Canyon. The present mill and campsite (fig. 1) are to the west and at a higher elevation

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[1] Work on manuscript completed March 1959.

[2] General manager, Baguio Gold Mining Co., Baguio, Luzon, Philippine Islands.

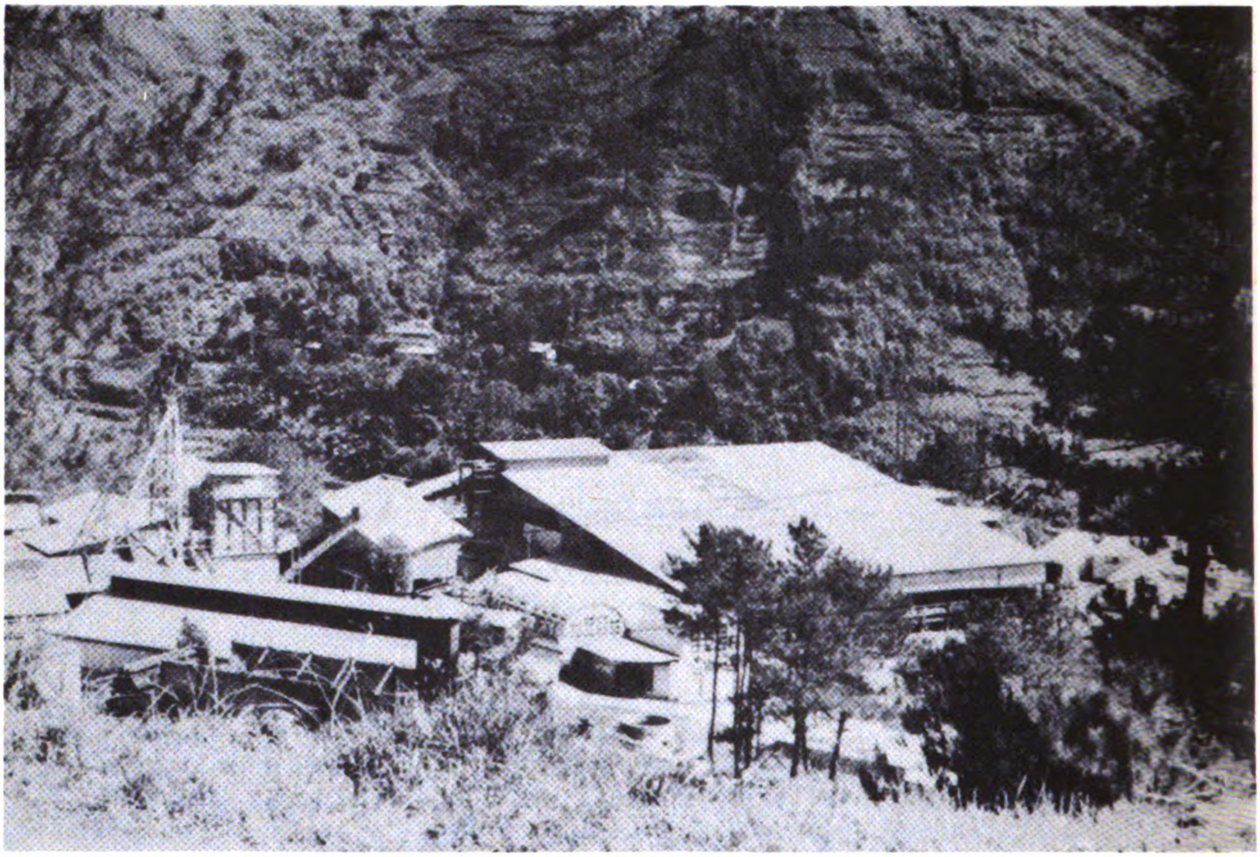

FIGURE 1. - Headframe, Mill, and Auxiliary Buildings.

than the prewar plant, which was completely destroyed during World War II. Regional topography is rugged, the mine area being surrounded by mountains comprising part of the Central Cordillera. Figure 2 shows the location of the property.

HISTORY AND PRODUCTION

The Baguio Gold Mining Co. was organized in May 1930, with acquisition of 13 mining claims. Gradually the holdings were increased, until the company now owns 126 full and fractional claims. Ownership of the company is approximately 70 percent Filipino and American. Production was begun in 1933 and was continuous until the outbreak of World War II in December 1941. The mine was reopened 4 years after the war ended, but the new milling plant was not built until 1951. Production was resumed in January 1952 and has continued uninterruptedly to date. An operating agreement signed May 1955 with the adjoining Gold River Mining Co. made available 55 additional claims for development. Since the agreement was signed, part of the mine production has come from Gold River ground. The two companies recently agreed to merge, with Baguio Gold Mining Co. taking over the Gold River property and assets on an exchange-of-shares basis. The merger was completed in December 1957. The company maintains

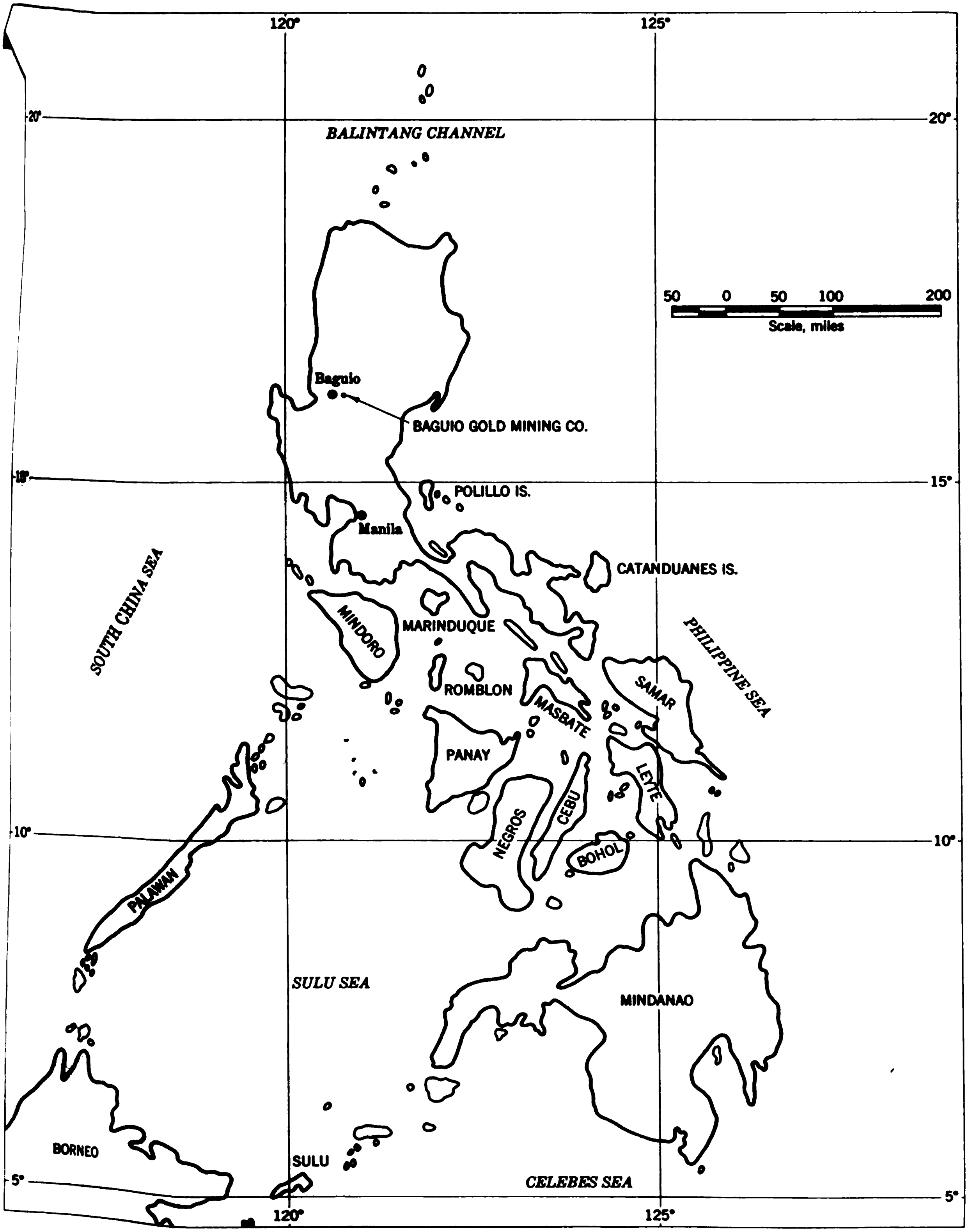

FIGURE 2. - General Map of Philippine Islands.

a Manila office; purchases are made there, and company business is handled. All other business is handled at the mine office. Table 1 gives data on annual production.[3]

TABLE 1. - Annual production, Baguio Gold Mining Co.

Year	Gold ore, tons	Value	Gold, ounces
1933..................	4,808	₱129,450.46	(1/)
1934..................	39,038	928,646.26	(1/)
1935..................	51,645	876,245.39	(1/)
1936..................	62,792	1,054,561.65	(1/)
1937..................	74,332	1,267,775.24	(1/)
1938..................	106,211	1,727,388.00	(1/)
1939..................	118,224	1,820,496.32	(1/)
1940..................	142,515	2,226,682.00	(1/)
1941 (10 months)......	131,015	2,222,498.00	(1/)
1952..................	92,157	2,099,882.00	20,864.02
1953..................	125,042	3,105,326.00	29,801.27
1954..................	137,232	3,178,829.47	29,449.42
1955..................	144,309	2,788,784.85	26,387.44
1956..................	150,576	3,522,760.72	31,440.65
1957..................	138,951	3,658,182.91	29,463.73

1/ Figures not available.

PHYSICAL CHARACTERISTICS OF ORE AND ENCLOSING ROCKS

The geology of the district has been discussed by Livingstone,[4] Smith, Reed, Schafer, and others.

The principal rocks of the district consist of Mesozoic sediments intruded by diorites. These were intruded by later andesites and diorites. A diorite intrusion, called Baguio Gold diorite by Livingstone, appears to have been a controlling factor in ore deposition and is more or less centrally located in the vein system.

Livingstone states:

> The ore deposit like others in the district is of the epithermal type. The gold is very fine and occurs in the native state in a quartz and calcite gangue in veins 3 to 15 feet wide, usually 4 or 5 feet. Traces of tellurides are known to exist in certain parts of the district, but their presence has not been detected at this property. Traces of galena, chalcopyrite, and sphalerite are associated with the

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[3] In all tables and data on costs, values are expressed in Philippine pesos (₱), valued officially at $0.50 and unofficially at ± $0.30 (1957).

[4] Livingstone, Clifton W., Mechanics of Vein Formation in the Northern Half of the Baguio District: Eng. Min. Jour., vol. 140, No. 9, September 1939, pp. 38-42.

quartz mineralization. Some marcasite and an abundance of pyrite occur as primary constituents of the intrusive, as well as being associated with the later surges of the mineralizing solutions. Their presence at Baguio Gold usually indicates an impoverishment of values. The presence of rhodochrosite indicates better than average values. Much of the manganese present has been and is being transported and deposited as colloid. Secondary enrichment of the ore deposit is not to be expected with the calcite gangue and basic nature of the ground water near the veins. Gypsum and anhydrite are abundant at Baguio Gold as well as elsewhere in the district. Their origin and relation to the ore deposits are matters of speculation by operators and geologists.

The veins strike east-west and northeast-southwest. Livingstone considers the east-west veins as tension fractures and the northeast-southwest veins as formed by extensive shearing movement. Generally the veins striking northeast-southwest have a heavy gouge on the hanging wall. Dips range from almost vertical to about 25°. Ore shoots are irregular, ranging from very small lenses to shoots several hundred feet laterally and vertically. Many hanging- and foot-wall splits contain considerable ore.

The ore is relatively soft but "hangs up" well. Where gouge is present on the hanging wall, it air-slakes and causes a dangerous, slabby condition. The country rock will generally stand in drift without timber, except near veins where it is blocky and subject to air-slaking.

The country rock is andesite, which has been intruded by diorite and by later andesite dikes. Jointing is almost always sympathetic with nearby vein systems. As a crosscut approaches a vein, jointing in two directions becomes more prominent, and in the immediate vicinity of a vein jointing in three planes results in short ground that requires support.

The veins and fractures are the result of shearing, tension, or both. The shears are accompanied by a heavy gouge, locally called "bull hide." The tension sections frequently show domino breccia. There is only occasional evidence of movement within the veins after vein formation.

Seasonal ground-water variation interferes with orderly mining. In the wet season, stope hanging walls are noticeably weaker and subject to runs of ground. At the height of the rainy season approximately 2,000 g.p.m. is pumped from below level 6. This amount is about double that pumped during the dry season. Insofar as it is possible, 100-percent standby pump capacity is maintained. Small pumps (60 hp. and less) in various locations lessen the problem of drainage to the pump station and cut down on peak power loads when the pumps switch on and off. Automatic control, with float switches, is used where possible.

METHODS OF PROSPECTING AND EXPLORATION

Prospecting is done by following veins and structures underground with drifts and sinking and raising on the veins. Crosscutting and diamond drilling are used to look for new veins and parallel structures. The prevalence of discontinuous shoots makes it necessary to do considerable drifting and crosscutting in country rock, but prospecting is done on the vein if ground conditions do not require excessive maintenance. Because of erratic values and poor core recovery in the vein, diamond drilling is used to locate structures rather than as a basis for estimating the value of ore in the drill holes.

For accounting purposes, all underground prospecting and exploration are considered development. In 1957 this work comprised 13,811 feet of crosscutting and drifting, 10,178 feet of raising and subleveling, and 13,800 feet of diamond drilling. All major development on the level is considered capital development. All stope development is considered operating development and is a part of the direct mining costs.

SAMPLING AND ESTIMATING RESERVES

Drifts, raises, winzes, and sublevels are sampled every 5 feet in a vein. Crosscuts and openings that do not follow a vein are sampled whenever vein material shows. Where possible, a right and left side sample is taken in openings. Working stope faces are sampled daily.

In all back and face samples, a channel is cut across the vein, yielding a 50-pound sample which is broken to uniform size and coned and quartered on the spot. Hammer and moil, plus a 3-foot square of canvas, are used for sampling. Production samples (a small scoop from each car) are taken by the skip-pocket attendant. The cut samples, minus a 20-percent dilution factor, check the car grab and other production samples within a few percent.

In spite of continuous stress on clean mining, some waste is mixed with the ore as it is mined because of weak walls and included bands and lenses of waste in the veins. The use of a dilution factor has proved necessary to allow for this waste in making tonnage and grade calculations. From past experience a 20-percent increase in tonnage and decrease in grade have been adopted. Dilution is more troublesome in the sections of the mine that have flat-lying veins.

Ore-reserve tonnage is calculated by figuring the grade, volume, and value of a block from the cut samples. Volume is increased 20 percent for dilution, but total value is computed using true volume calculated from vein width. Grade is then figured by dividing total value by tonnage including dilution. Results check production samples within a few percent.

Ore reserves are calculated monthly, with adjustments for mined-out and newly developed tonnage, and are recalculated independently twice each year.

METHODS OF DEVELOPMENT AND MINING

Development

The San Pablo shaft and Hoover tunnel (adit) are the main development openings. In 1957 work was done on levels 4, 5, 6, 7, 8, and 9; 6, 7, and 8 were the most active levels. The ore body being developed comprises discontinuous lenses and ore shoots along a main east and west vein system. Dip and strike vary widely, and ore shoots are limited both vertically and horizontally; thus, a vigorous exploration and development program is necessary. All development work is on an incentive system. Figure 3 shows the shaft and other buildings and structures comprising the plant. Figure 4 is a section of the underground workings.

The San Pablo shaft has three compartments - two hoisting and one pipe and manway. The shaft is timbered, except for the first 150 feet below the surface, which is concreted. Shaft timber is local pine - 8- by 8-inch sets on 5-foot centers. The shaft is in good ground and gives little trouble except for worn guides and other minor repairs. Figure 5 shows details of the shaft set. Figure 6 shows the location of the shaft with respect to the surface and underground workings.

A shaft sinking crew consists of four miners and a capataz (jigger boss). Figure 7 shows the drill-round pattern. Usually 112 sticks of 8- by 7/8-inch DuPont Gelex No. 2 (45-percent) powder is shot per round. Three sinking machines drill a round in 4 hours, and a full shaft cycle takes approximately 30 hours. Mucking is done by hand, and auxiliary hoist and buckets transport the broken rock to the haulage level, where it is trammed to stopes for fill or outside for disposal. Unless water is excessive, sinking averages 4 feet per day.

Drifts and crosscuts are approximately 6 by 7 feet. Simple sets of 8- by 8-inch local pine are used. (See fig. 8.) In ordinary ground, sets are spaced 6 feet apart; in heavy ground, as under veins being mined, sets are more closely spaced. Some crosscuts in country rock stand without support, but many air-slake and get slabby. Drifts are driven in the footwall to save on timbering expense.

Figure 9 shows the standard drift round. Five or six sticks of 8- by 7/8-inch DuPont Gelex No. 2 are used per hole and blasted with No. 6 caps and mahogany fuse. Drift crews comprise two men per shift or, with a long tram, three men.

Jackleg drills are used for all drilling in raises, stopes, and headings.

Eimco 12-B mucking machines load into 1-1/2-ton company-built side-dump cars. (See fig. 10.) Under good conditions a 5-foot round can be drilled, blasted, mucked, and timbered in two shifts. Muck is disposed of as a stope fill, or hauled to the waste dump. The Hoover tunnel portal area is used as a waste dump.

Raises have two compartments. Usually stull and headboards are enough support; however, if the raise is in a steep or wide vein or if the hanging wall is bad, square sets are used. Raises are usually broken for a width of 8 feet and the height of the vein. If the raise is flat enough so that the muck has to be shoveled down, a scraper or tugger and car arrangement is used. (See figs. 11 and 12.)

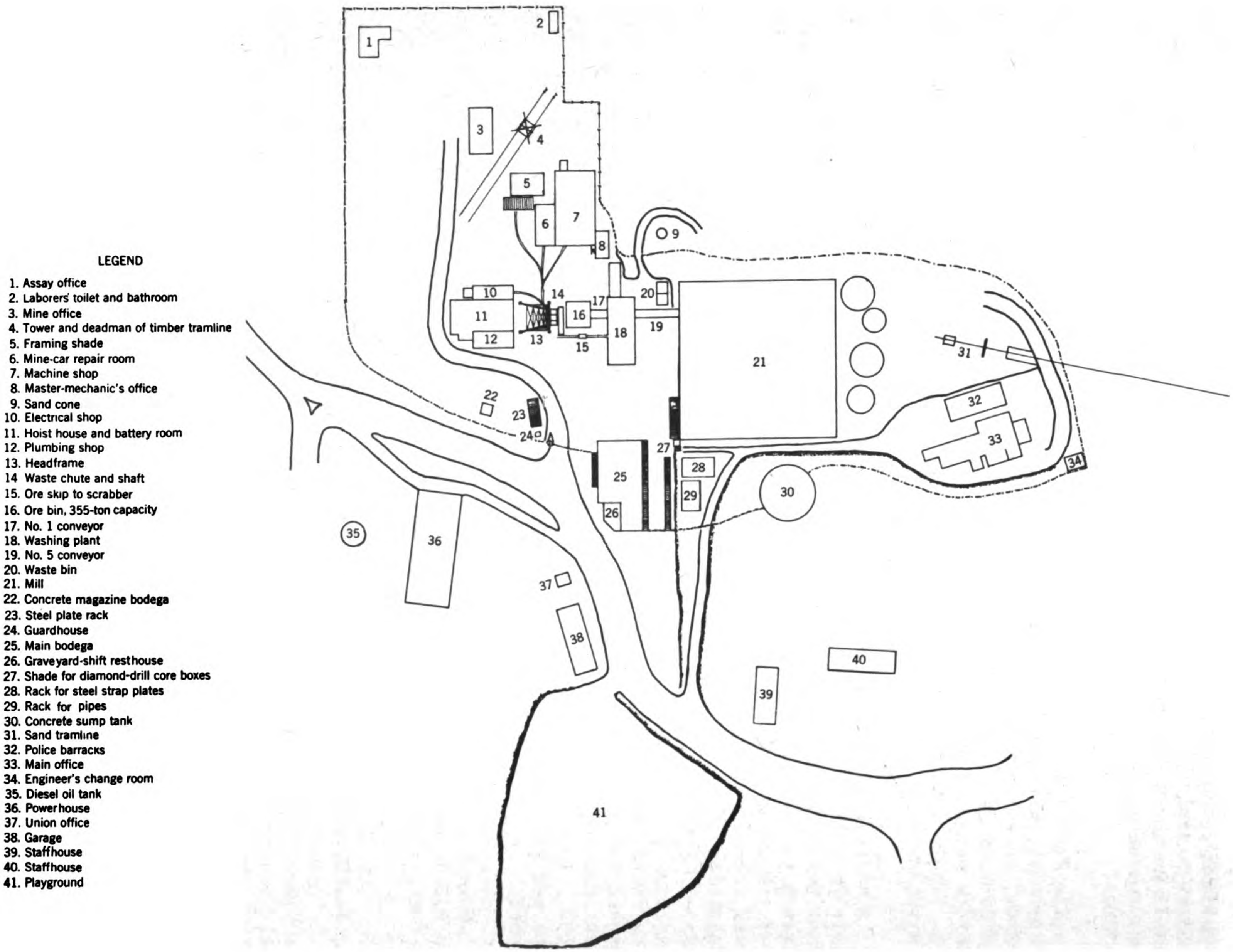


FIGURE 3. - Plant Layout.

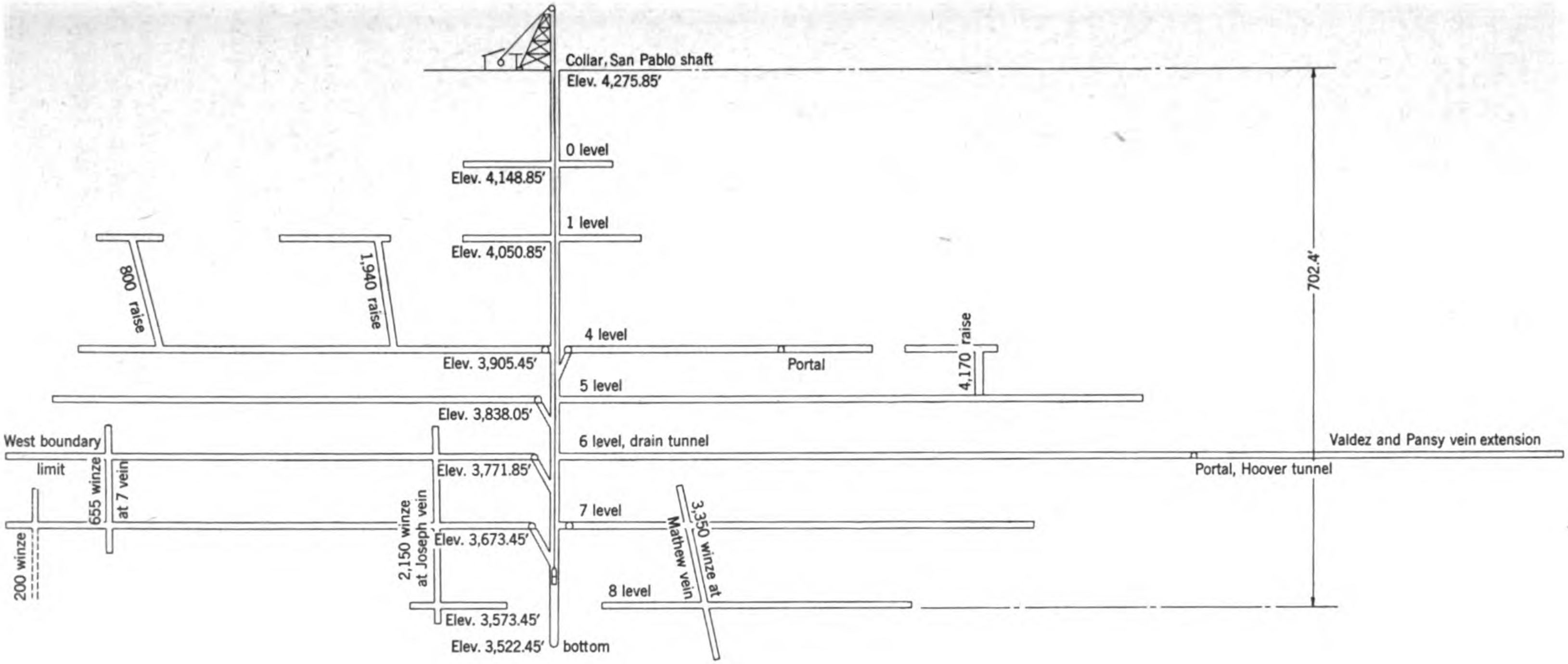


FIGURE 4. - Section Showing Underground Workings.

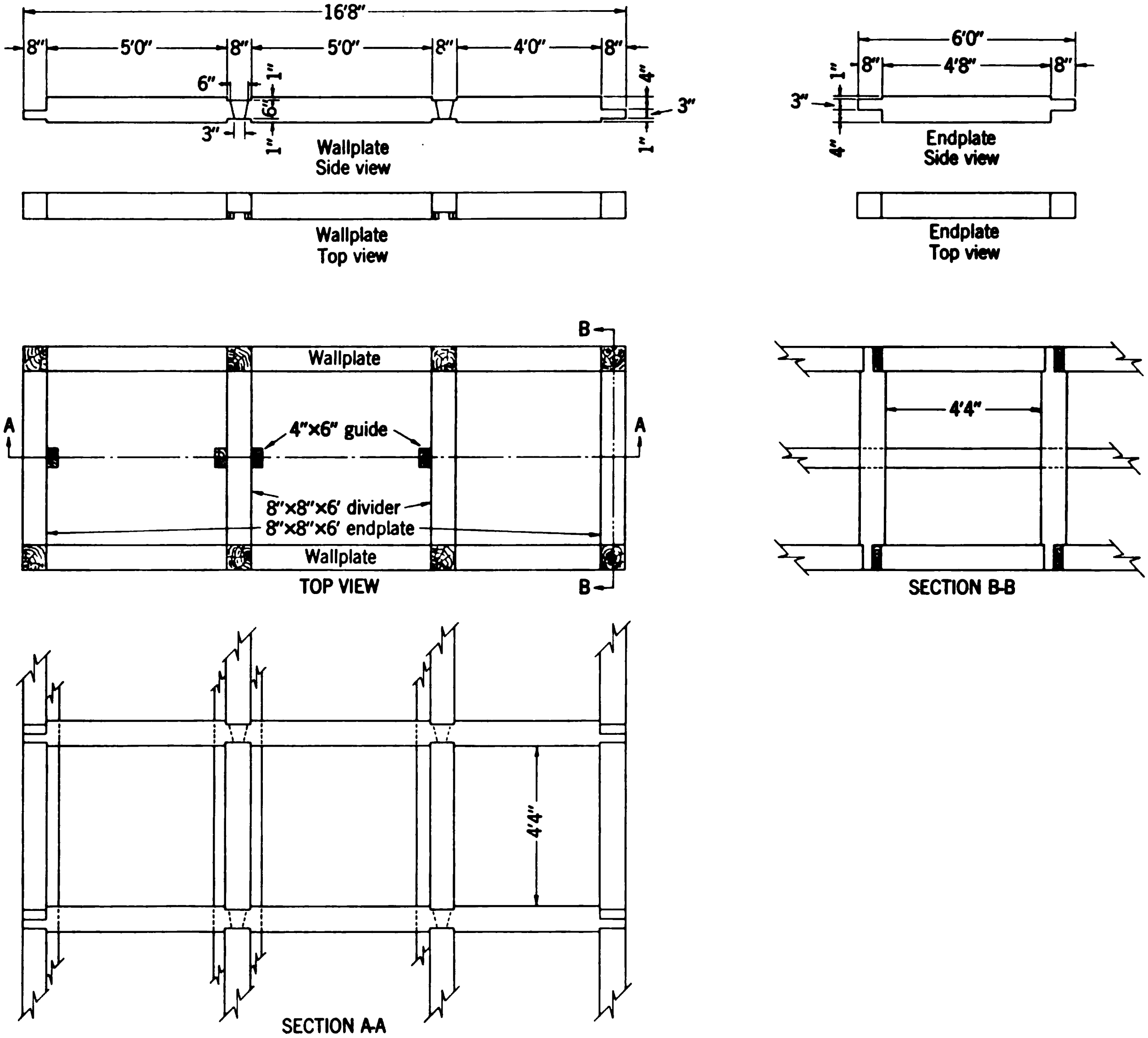


FIGURE 5. - San Pablo Shaft Set.

Statistics show that it is necessary to obtain about one-third of the ore from development to maintain a proper development, stope, and reserve balance. In 1957, approximately 2,100 feet of development openings was driven per month. The company operates three diamond drills in the mine, drilling an average of 1,500 feet per month. Diamond drilling has been moderately successful as a method of finding ore.

Baguio Gold has never had a large ore reserve (usually enough for about 18 months), but over the years development has paced production. As the mine becomes older, deeper, and more spread out, maintenance of reserve is more of a problem.

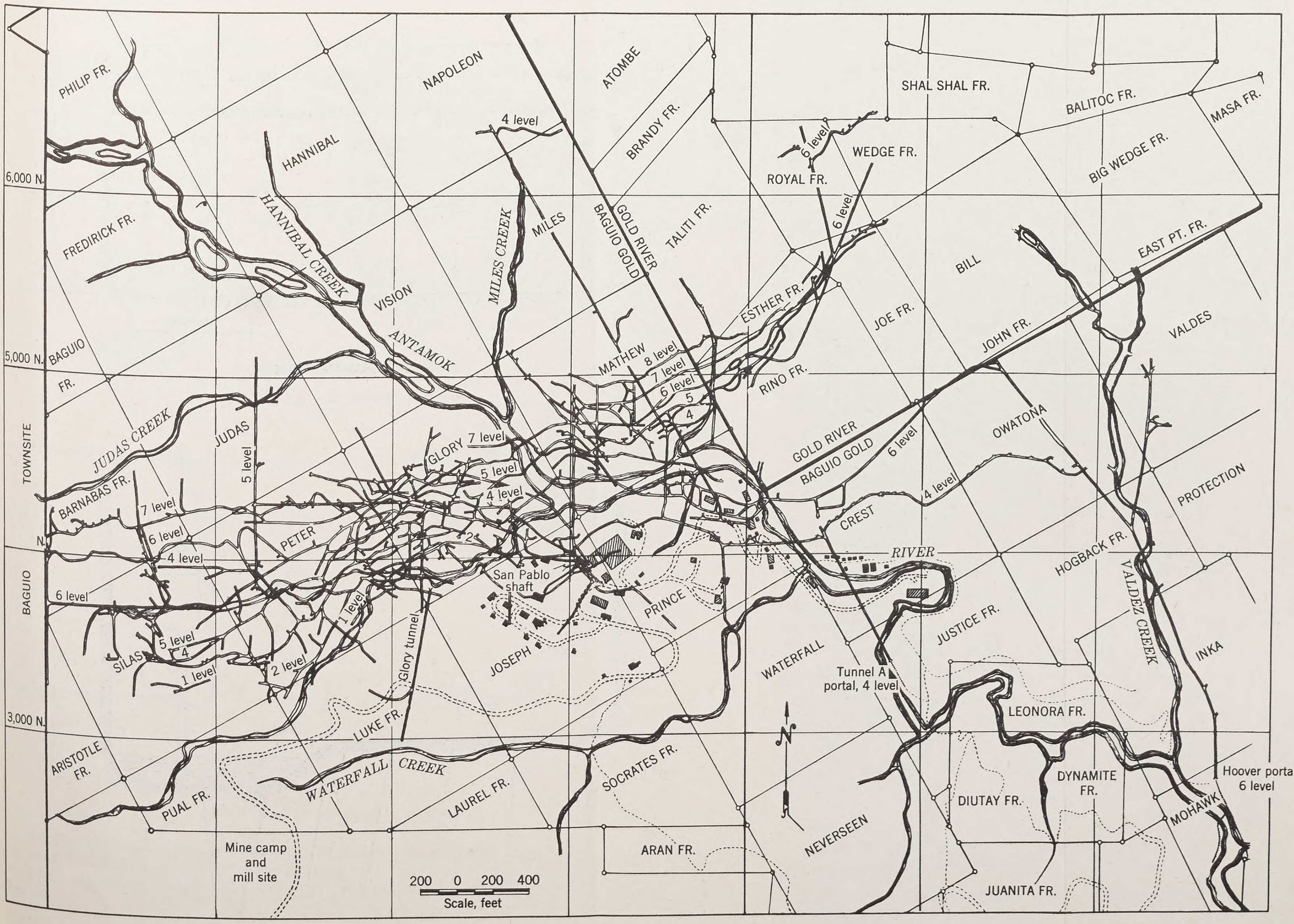
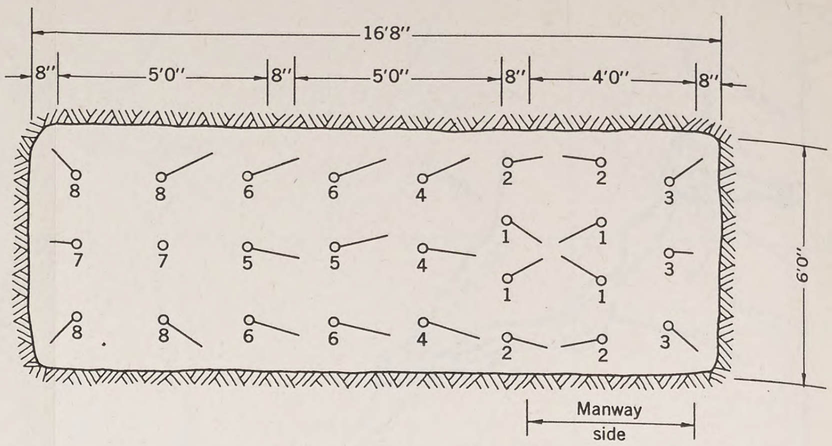
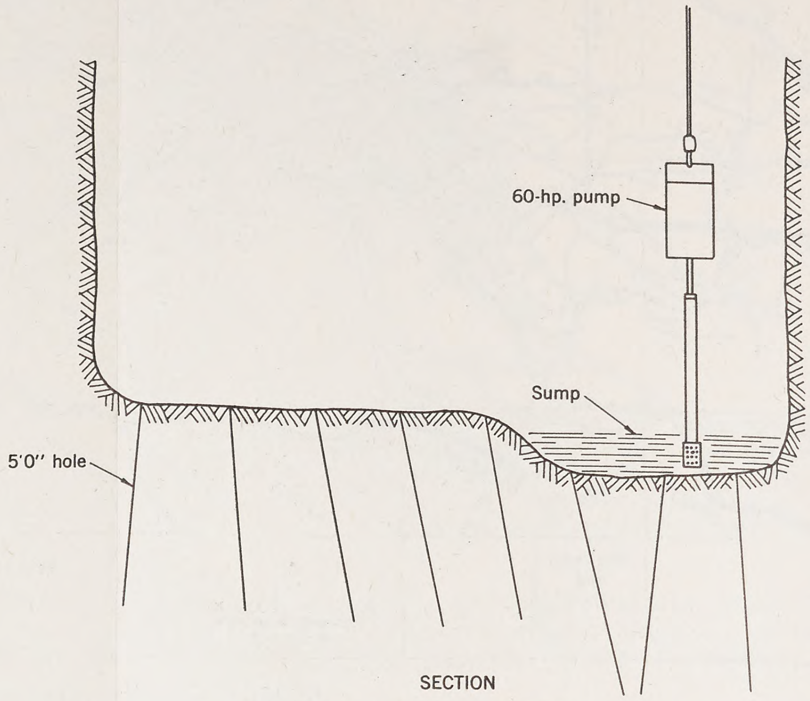


FIGURE 6. - Map Showing Underground Workings.

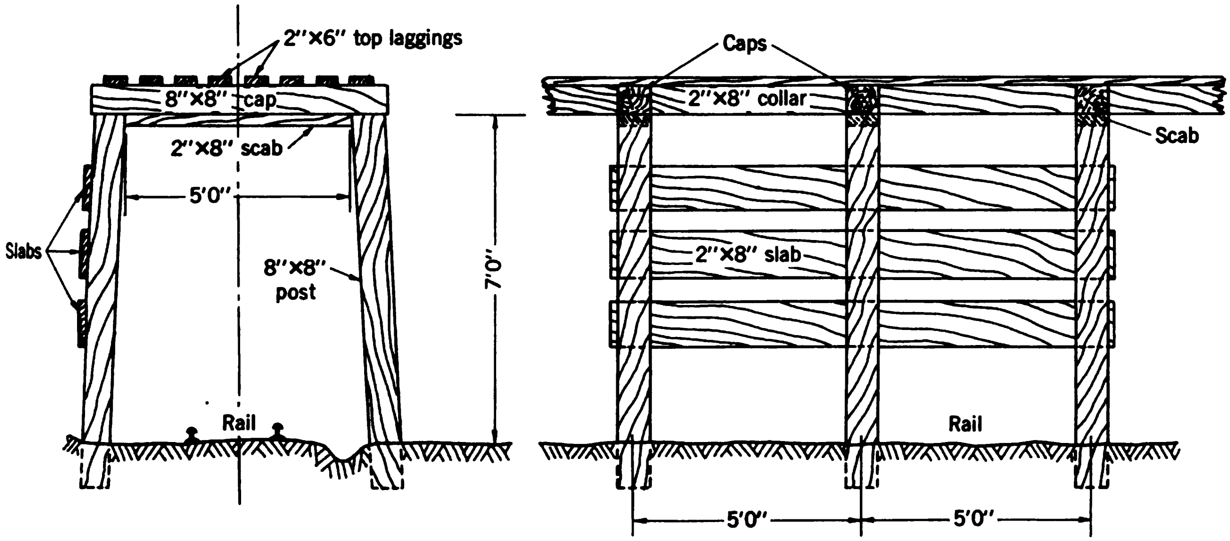


PLAN, FOR 3 COMPARTMENTS



SECTION

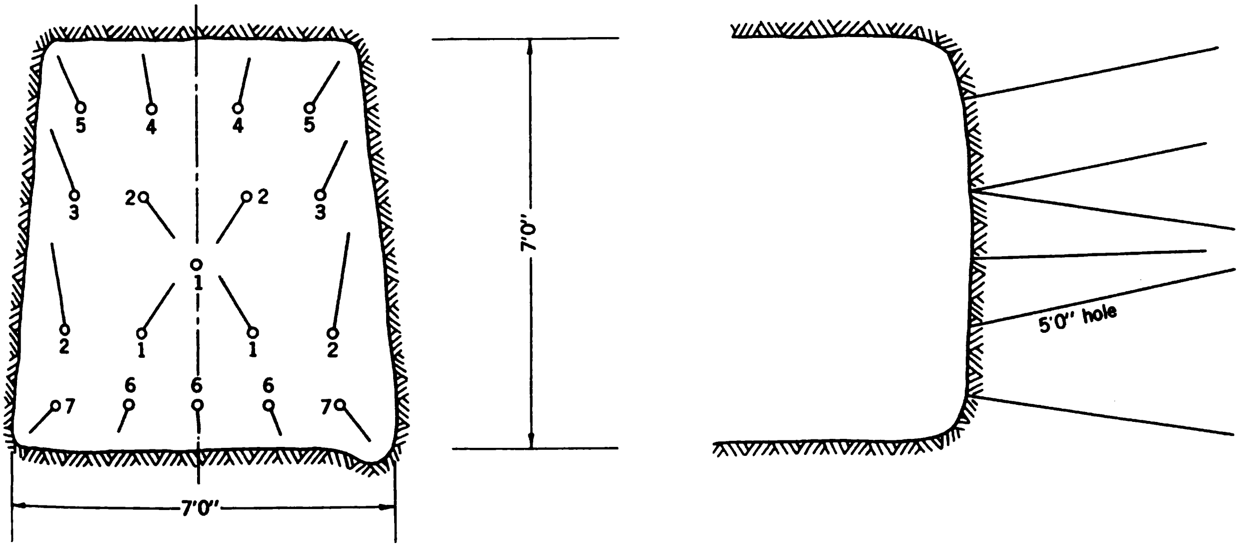
FIGURE 7. - San Pablo Shaft Drill Round.



SECTION
STANDARD DRIFT SET

LONGITUDINAL SECTION

FIGURE 8. - Standard Drift Set.



FACEPLAN

SECTION

FIGURE 9. - Standard Drift Round.

In flat-lying veins, a sublevel is driven midway between levels to facilitate mining and filling. In some places 100 feet vertically is 230 feet along the vein. On most sublevels a 1/2-ton car (fig. 13) is used for ore and fill tramming.

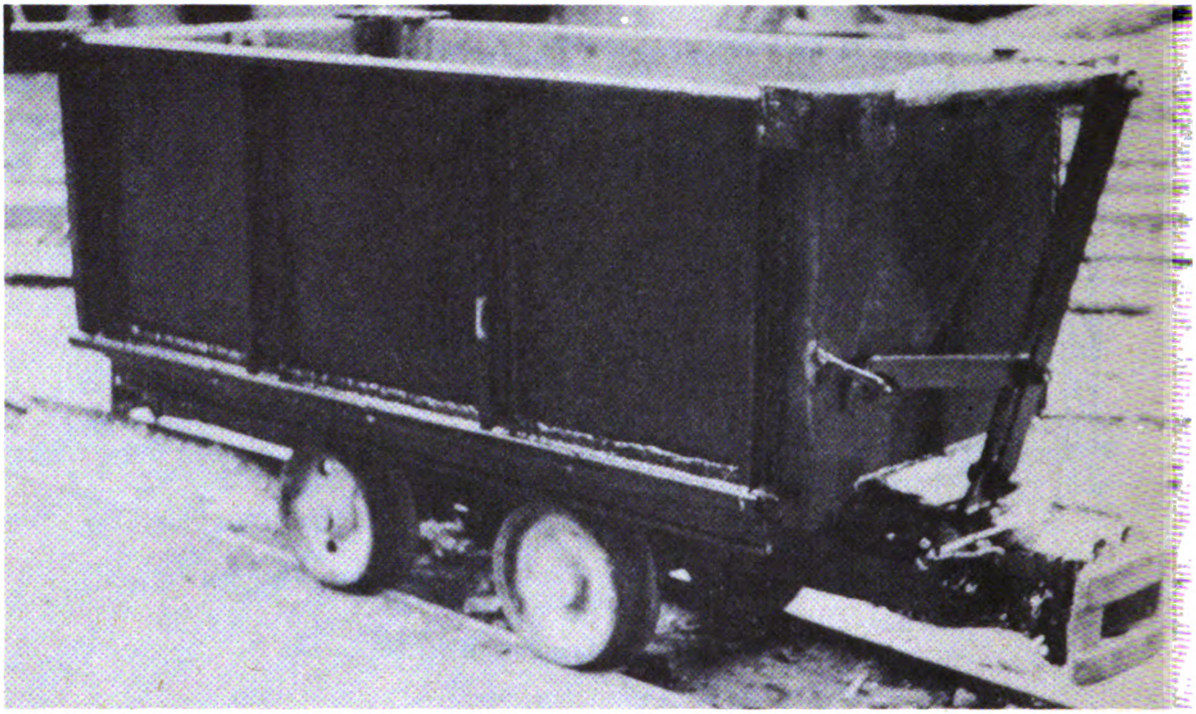


FIGURE 10. - Company-Built 1½-Ton Side-Dump Mine Car.

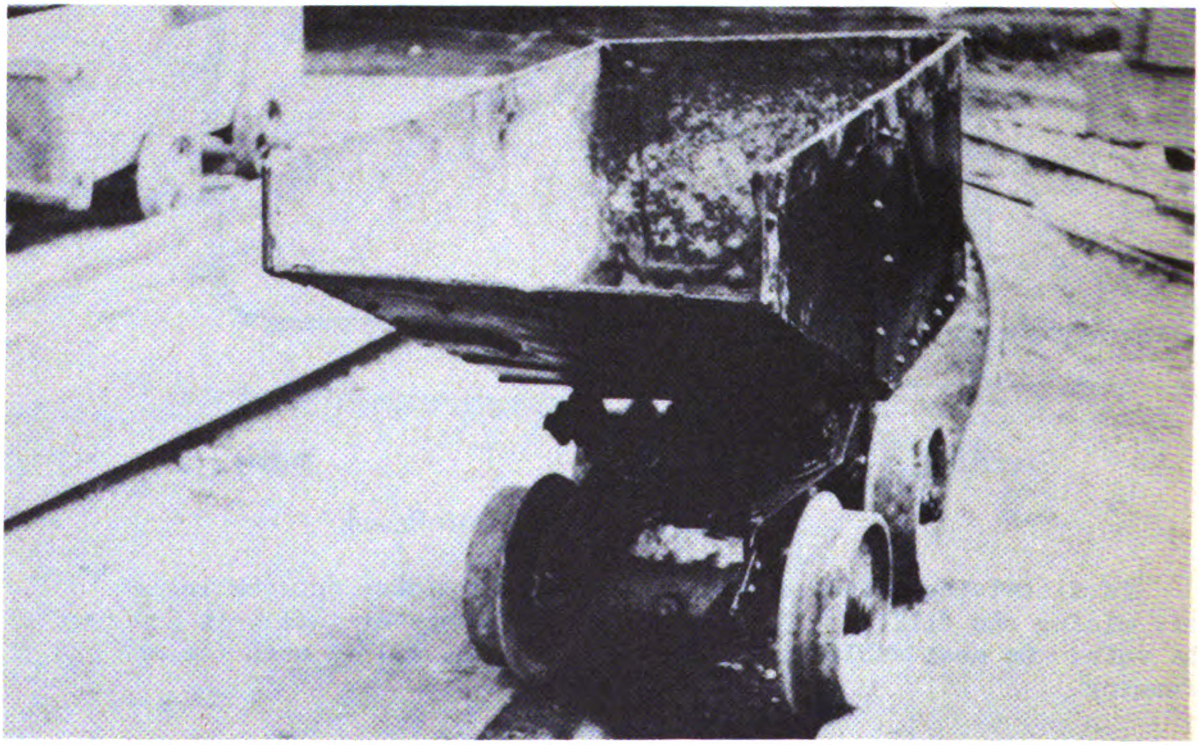


FIGURE 11. - Company Built ½-Ton Stope Car.

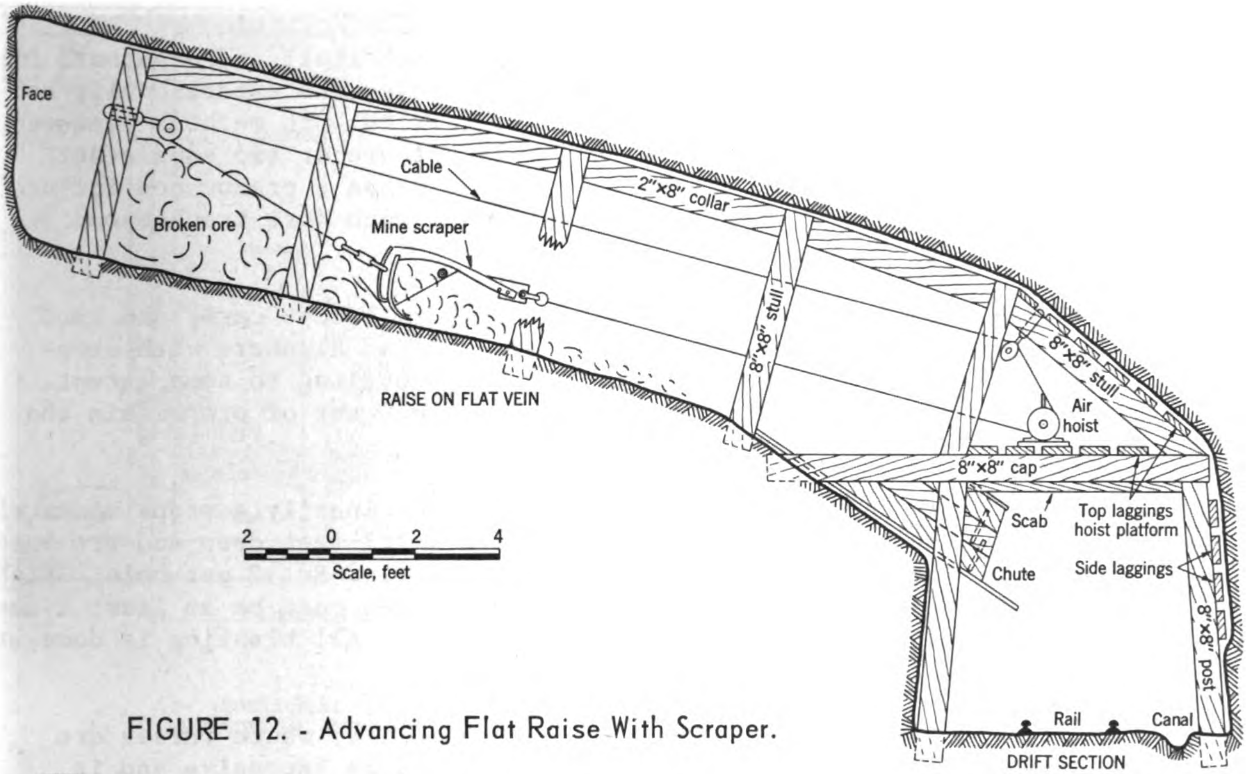


FIGURE 12. - Advancing Flat Raise With Scraper.

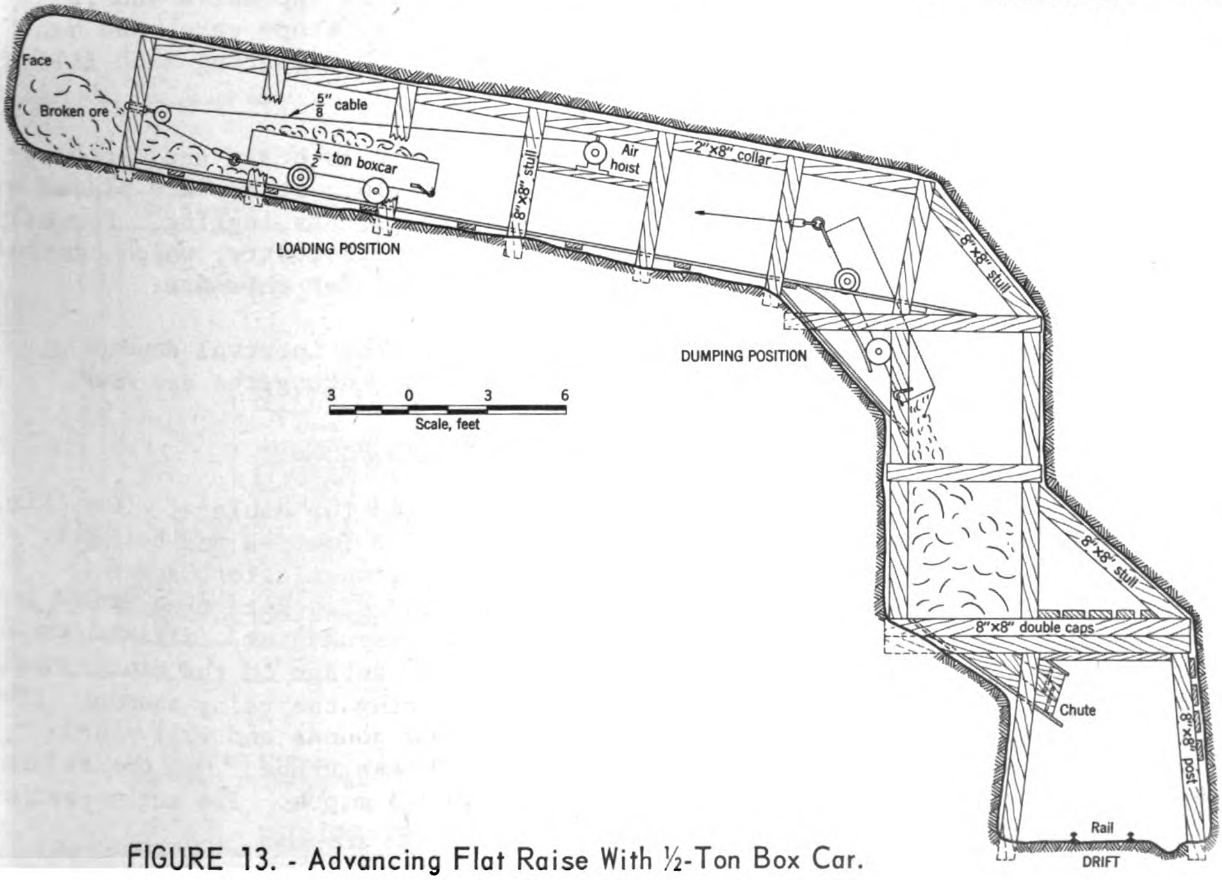


FIGURE 13. - Advancing Flat Raise With ½-Ton Box Car.

Mining

Cut-and-fill mining is used where possible, with stull and headboard for ground support. (See fig. 14.) Wide stopes or those with exceptionally bad hanging wall are mined by square sets (fig. 15). With both methods frequent filling is necessary, usually after 8 to 12 feet of ore or two square-set floors have been removed. The attitude of the vein has a pronounced influence on difficulty of support; the flat-lying veins are much more troublesome and dangerous.

Ore in the stopes is moved by gravity, slushers, stope cars, and hand shoveling. The use of small, double-drum, air-powered slushers with shop-built, 24-inch scraper buckets has replaced hand shoveling to some extent. Chutes are spaced close together to keep lateral movement of ore within the stope to a minimum.

Stope crews use jackleg drills exclusively. Ordinarily a stope miner will blast 20 to 30 holes at a time. These holes are 4-1/2 feet deep and are loaded with four or five sticks of 8- by 7/8-inch DuPont Gelex No. 2 per hole. Slabbing rounds are used where possible. Many drill holes must be at least 2 feet from the hanging wall to prevent excessive dilution. All blasting is done at lunchtime or at the end of the shift.

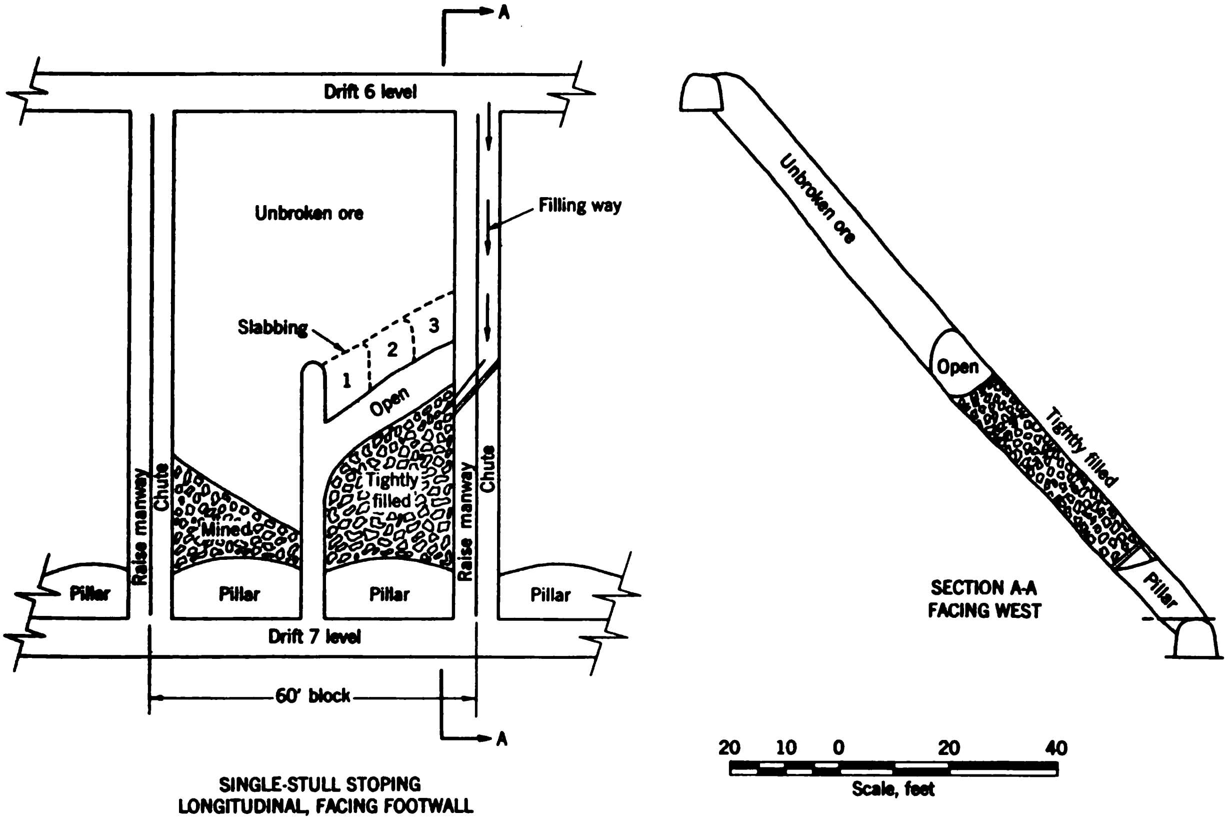
Fill is waste rock from development. Occasionally, waste raises are driven into the hanging wall. This method is much more expensive and is avoided if possible. Fill is distributed by slushing, stope cars, and hand mucking. The company is experimenting with methods of preparing sand fill from mill tailings.

Timber is local pine - a short-fibered wood that is heavy and not very strong. Square sets are framed, as shown in figure 16. Stulls are placed with headboards and lagging. (See fig. 17.) Slabs are used as lagging. Formerly, pole lagging was used. Now, the Philippine Bureau of Forestry, which controls all commercial logging, prohibits cutting small trees for this use.

Chutes are spaced approximately 30 feet apart, the interval depending somewhat on vein characteristics. Simple two-board chute gates are used.

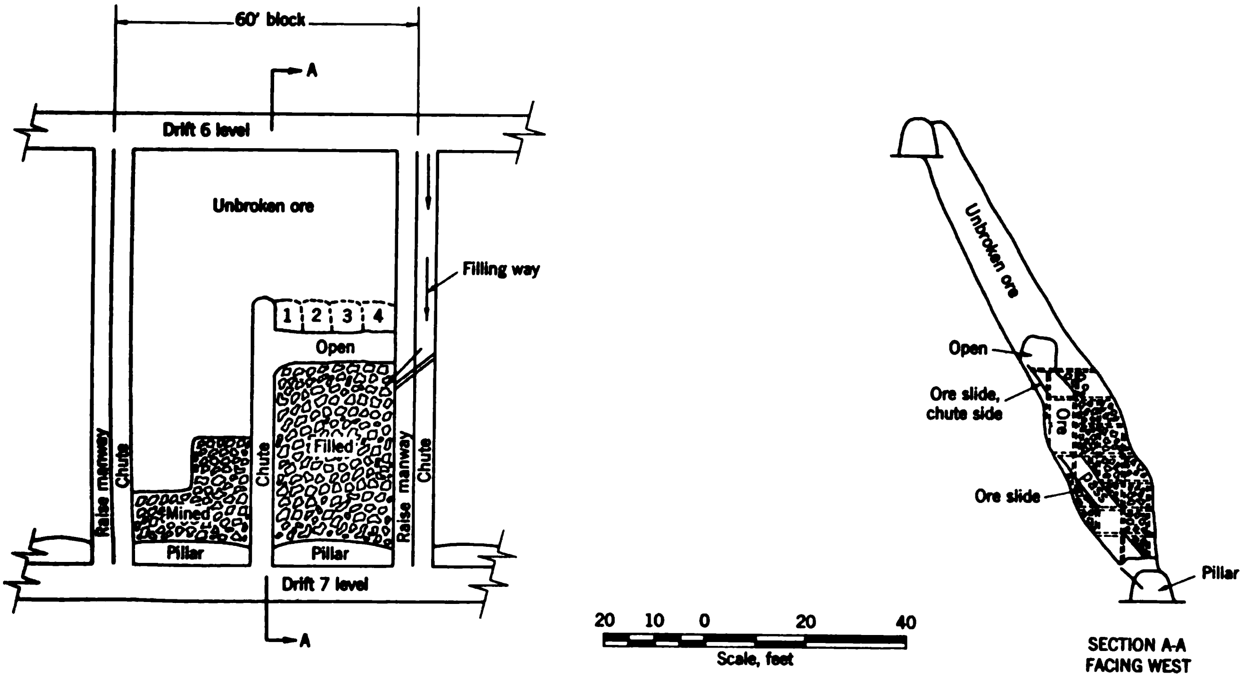
Underground Transportation

Five-ton, shop-built diesel locomotives are used for haulage. (See fig. 18.) These locomotives comprise a 1-inch plate frame (welded and bolted), a Hercules DOOD engine, a 1949 Ford truck clutch and transmission, and a Brookville or SES planetary gear driven to chain and sprockets that drive all four wheels. The brake, a Ford-truck brakedrum and mechanism, is fixed on the horizontal differential jackshaft - an important advantage in the mine, where mud and water foul ordinary wheel-brake rigging during the rainy season. The locomotives have a calculated drawbar pull of 2,500 pounds and will start eight loaded 1-1/2-ton cars on a 1-1/2-percent adverse grade. Top operating speed is about 8 m.p.h., but normal speed is about 3 m.p.h. The engine exhaust



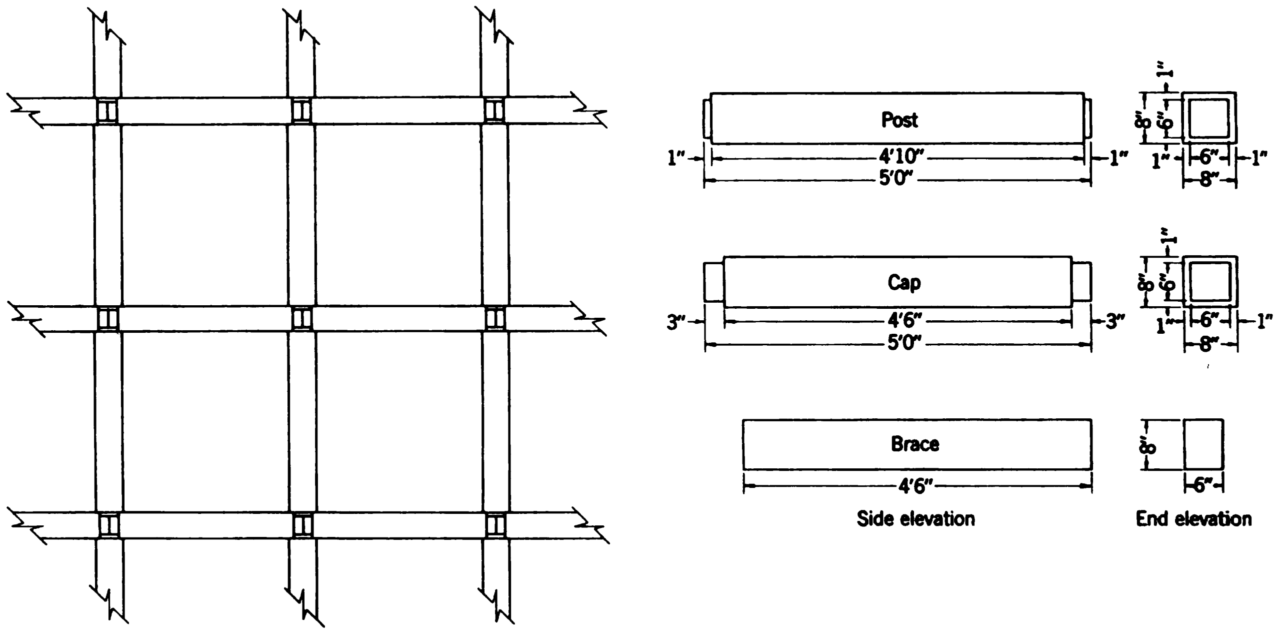
SINGLE-STULL STOPING
LONGITUDINAL, FACING FOOTWALL

FIGURE 14. - Cut-and-Fill Stoping With Stulls.

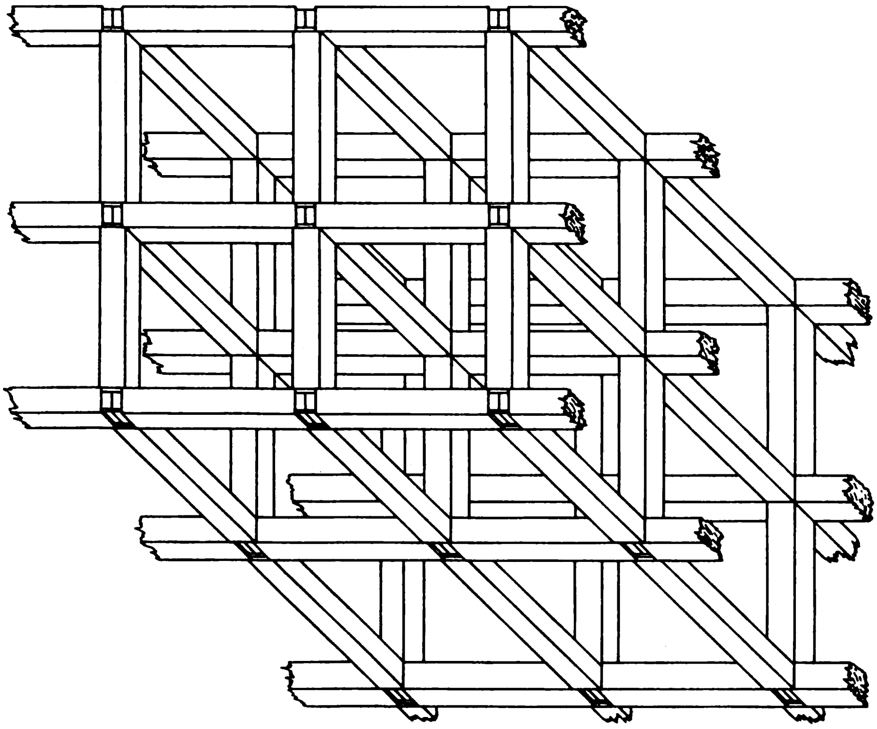


SQUARE-SET STOPING
LONGITUDINAL, FACING FOOTWALL

FIGURE 15. - Cut-and-Fill Stoping With Square Sets.



Side elevation



Isometric view

FIGURE 16. - Standard Square Set.

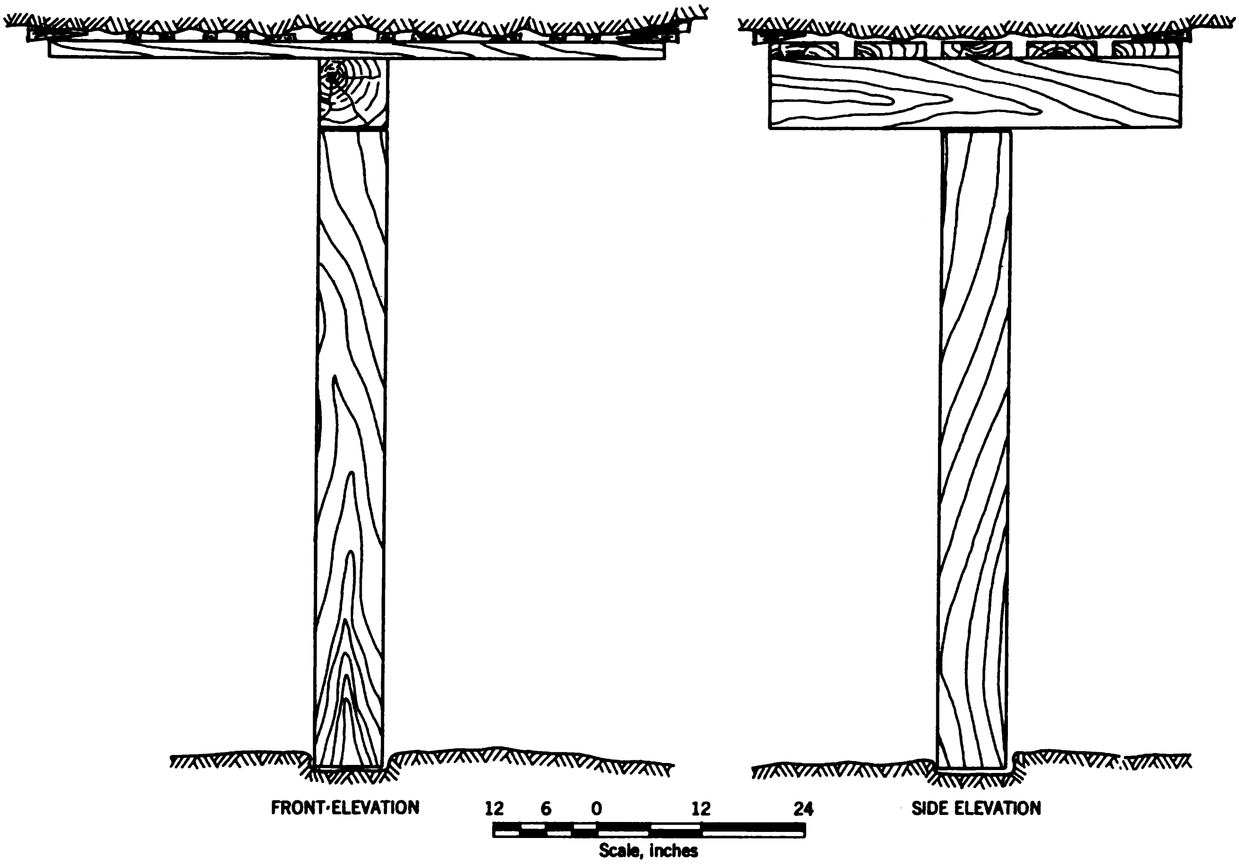


FIGURE 17. - Standard Umbrella Stull Set.

passes through a scrubber (fig. 19), and fumes are not objectionable when the engine is in condition. Use of a good grade of diesel fuel and proper maintenance of the engine are necessary.

The scrubber is made of brass tubes in a stainless-steel (10-gage) welded tank, which has a horizontal division on each side. Corrosion of mild steel necessitated use of stainless steel. The exhaust gases pass down through the tubes and percolate up through the water and the limestone above the perforated plate. Water is maintained at the level of the small plug. The scrubber is drained, flushed, and filled with clean water once a shift. Limestone is added as needed, usually a lump or two per day. Water cannot be sucked back into the engine from this scrubber.

These locomotives, although not as efficient as their factory-built counterparts, cost only about 60 percent as much. They are operable 89 percent of the time and require a general overhaul only after approximately 18 months of service. Hours spent on repairs are divided as follows:

	Percent
Lubrication	4.5
Electrical system	9.4
Engine repairs	15.3
Brakes, cooling, drive, and frame	33.0
General overhaul	34.6
Other	3.2

During the past year the locomotives hauled 106,000 ton-miles at a repair cost of ₱46,150, or ₱0.435 per ton-mile. Fuel cost was ₱0.077 per ton-mile.

The 1-1/2-ton side-dump cars (fig. 10, p. 14) are equipped with Hyatt roller bearings. Formerly, link-and-pin couplings were used, but now Willison automatic couplers have been installed. The cars have been completely rebuilt. New cars are fabricated in the company shop and are welded, except for wheels, bearings, and couplers. A new car costs about ₱1,200.

Train control is exercised by one train capataz on each level each shift. He makes up the crews and assigns duties, then stays on the level assisting the crews. Information on which stopes have broken ore is passed on by the capataz going off duty, or by written notes left in the mine office. Train signaling is done by police whistles - one blast to stop, two to push and three to pull cars.

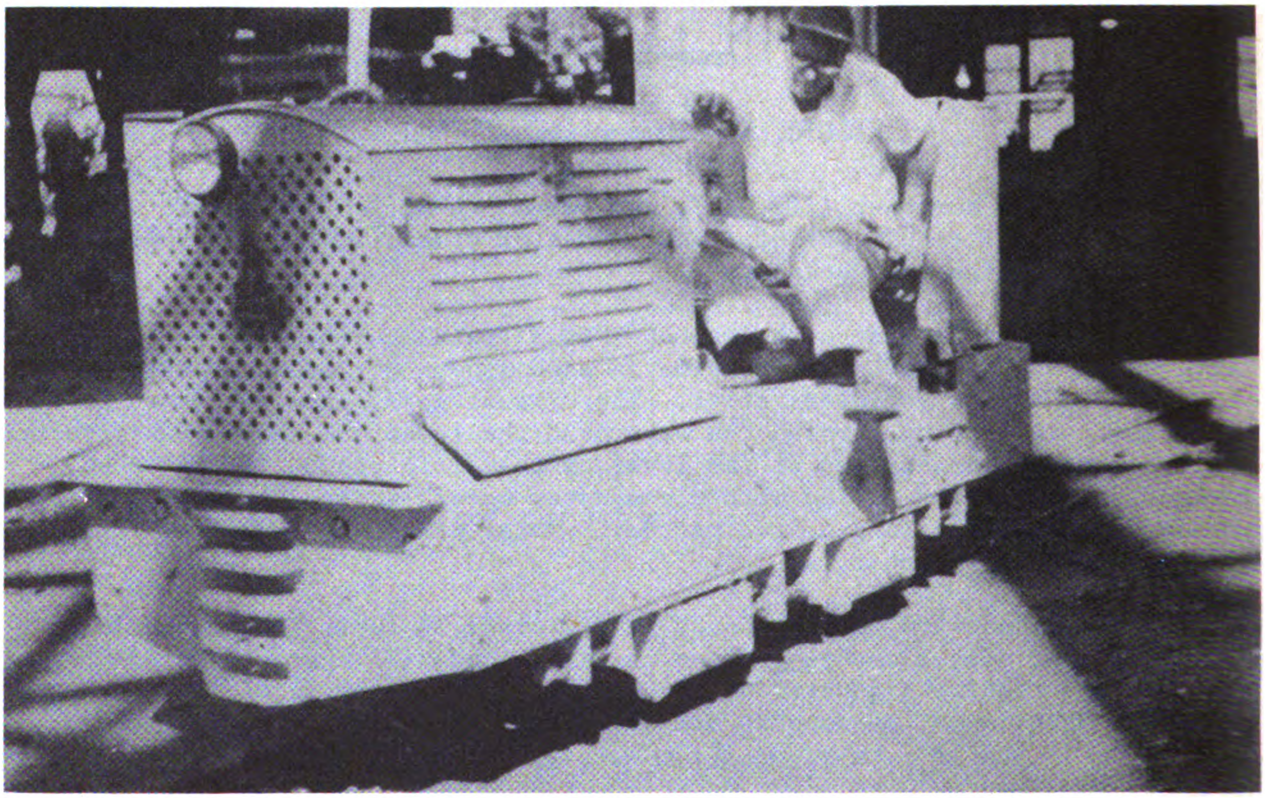


FIGURE 18. - Shop-Assembled 5-Ton Diesel Locomotive.

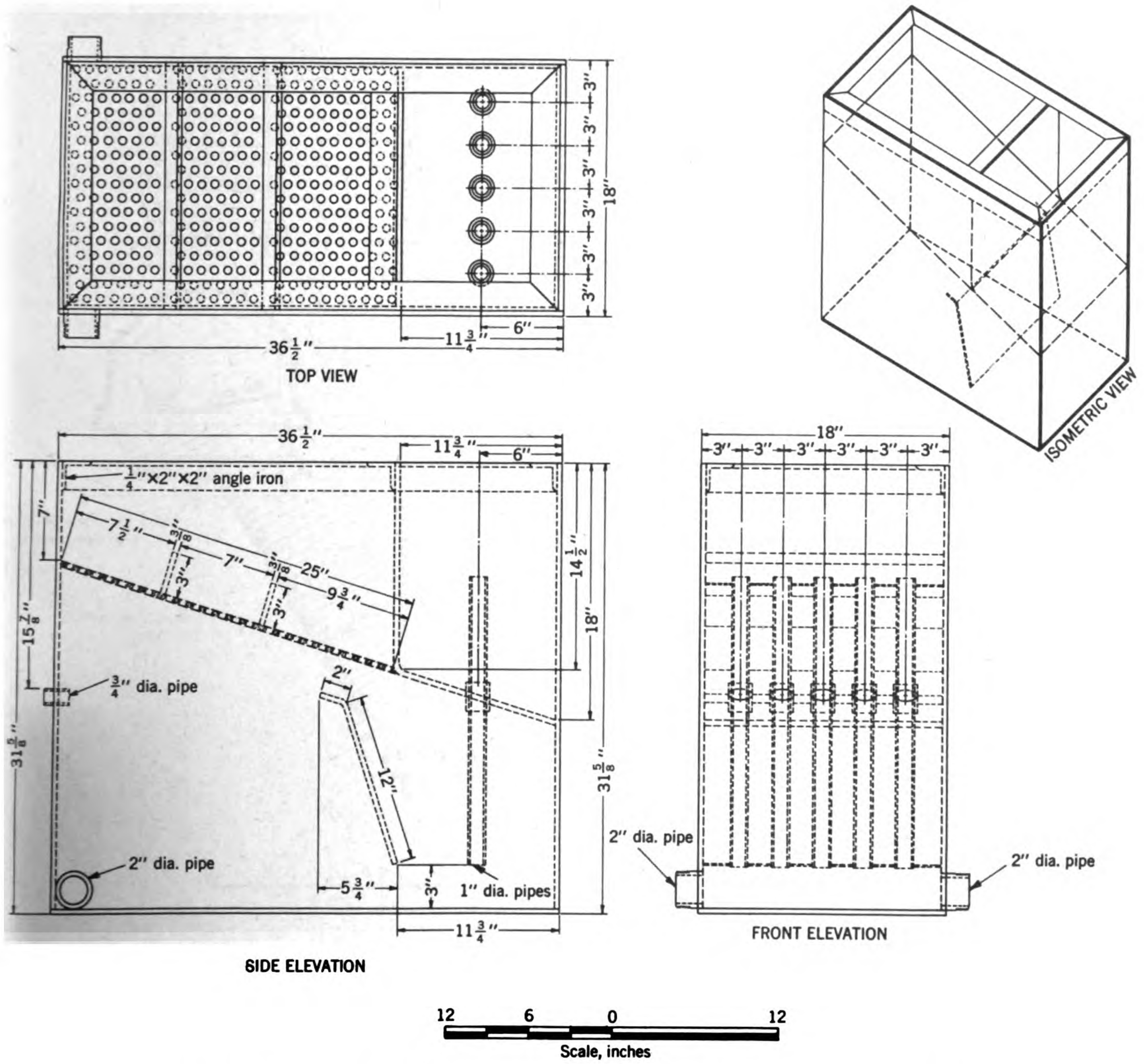


FIGURE 19. - Shop-Built Exhaust Scrubber for Diesel Locomotive.

Figure 20 shows the arrangement of skip pocket, measuring pocket, and gates. Skips are positioned and loaded with chairs. Loading a skip takes only a few seconds. Spillage is kept to a minimum by loading skips only moderately full and is cleaned off the spillage bulkhead daily and hoisted to level 7 with an air hoist and bucket in the manway compartment. The practice of cleaning spillage daily permits changing pumps in the shaft bottom without delay.

Conventional dumping horns dump the ore into the coarse-ore bin at the headframe. (See fig. 21.)

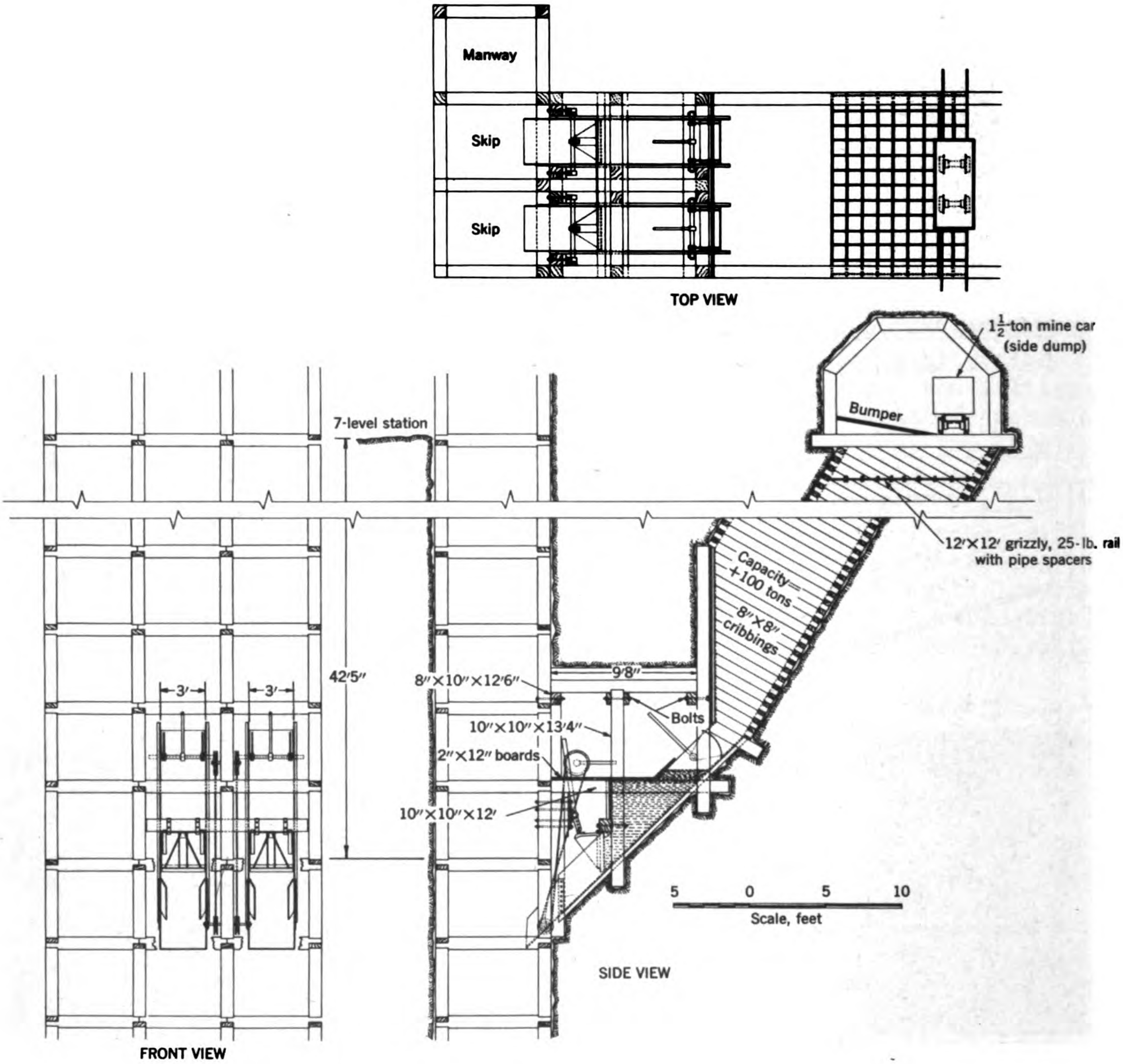
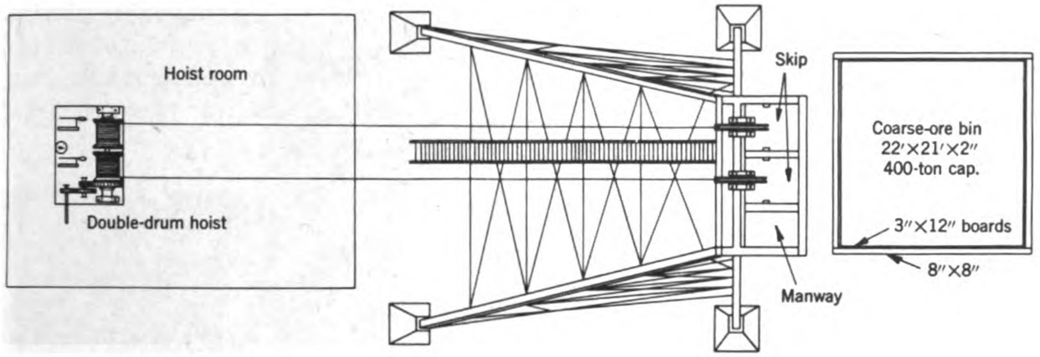
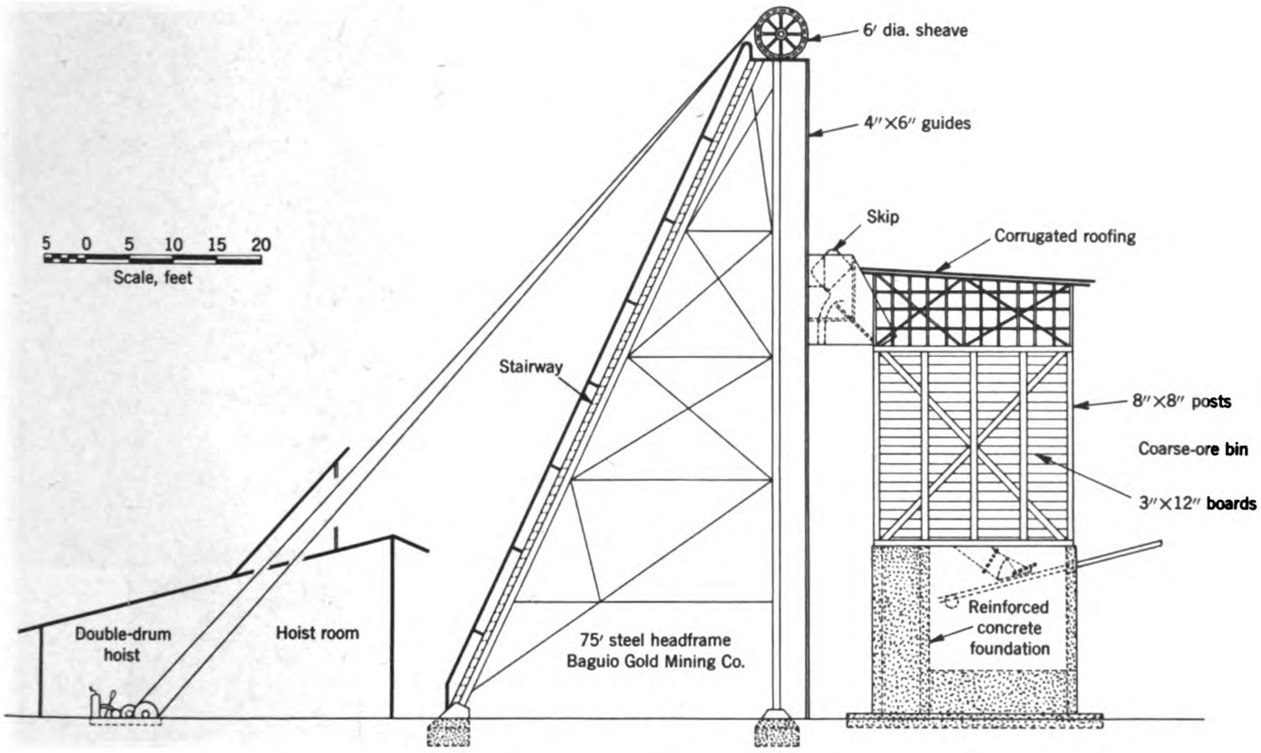


FIGURE 20. - Ore-Pocket Arrangement.

The main ore hoist is a double-drum Allis Chalmers hoist, 36 inches wide by 48 inches in diameter, equipped with post brakes, Lane clutches, and Simplex hoist controller. It is powered by 100-hp., wound rotor motor with an outboard General Electric thrustor brake and automatic overwind and overspeed controls. Two-ton skips are mounted above the man cage. (See fig. 22.) The hoist operates at a rope speed of 300 r.p.m. and has a capacity of 40 tons per hour from the lowest production level. Generally, timber and supplies are lowered during the day shift, and ore is hoisted during afternoon and graveyard shifts.



TOP VIEW



SIDE ELEVATION

FIGURE 21. - Hoist, Headframe, and Bin Arrangement.

The hoist rope is 6 by 19 (6 by 25) regular-lay, right-lay, preformed, improved plow-steel wire rope. The rope, hoist, cage, and sheaves are inspected daily. The rope is lubricated with ensis fluid, a low surface-tension compound that penetrates and "floats" the water from the inside of the rope, and heated, heavy gear lubricant that resists the washing action of the water dripping in the shaft. Lubrication is important and is done as thoroughly as possible. Sheaves are 60 inches in diameter and of standard wheel construction. The groove is reshaped by using a plate and lathe tool stand before a new rope is

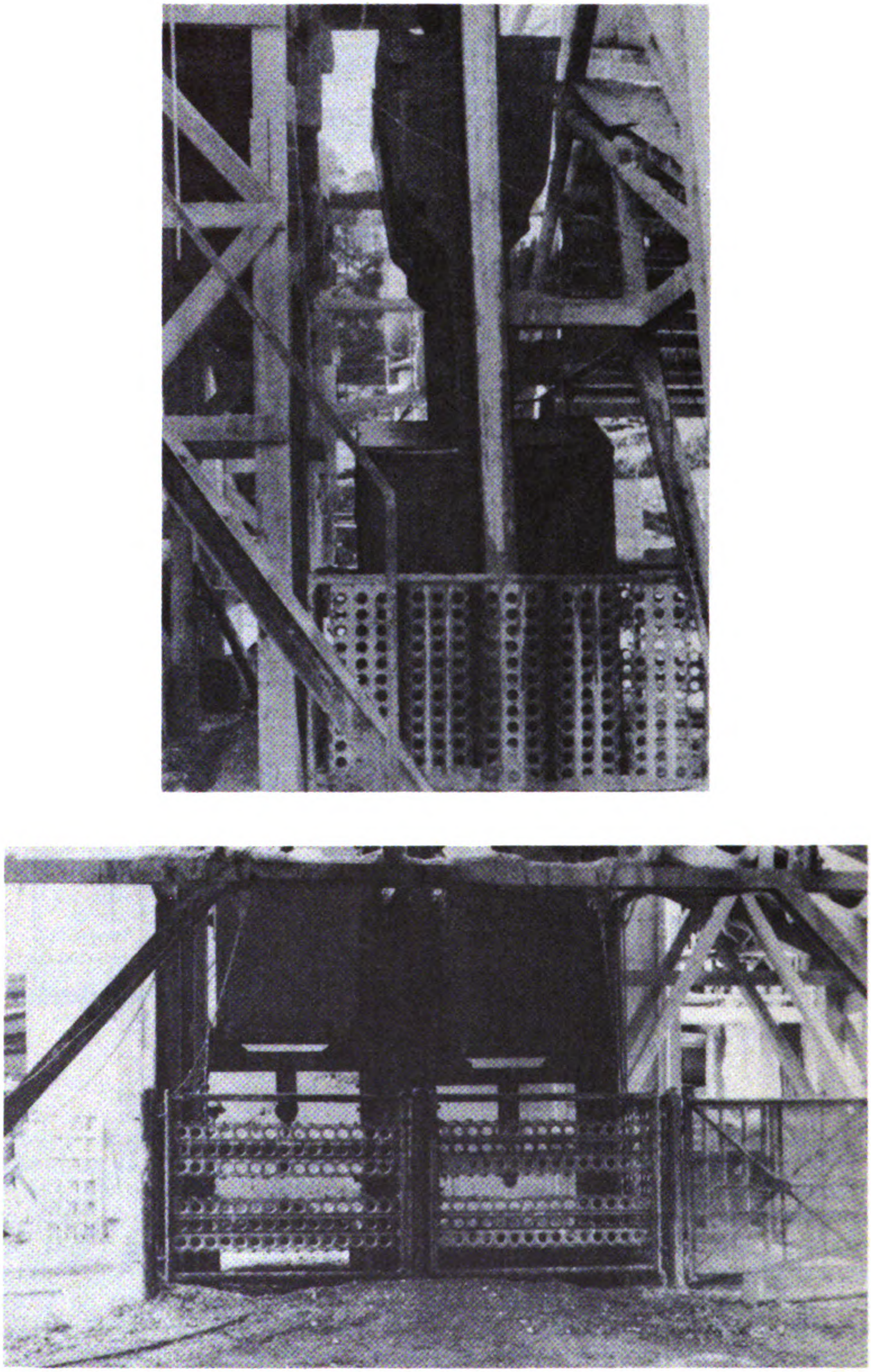


FIGURE 22. - Skip and Cage Arrangement.

installed. (See fig. 23.) Ropes are changed when wires begin to break, usually about once a year. Failure of the rope seems to be due to bending fatigue, distortion of wires, and wear of the individual outside wires to about 60 percent of their original size.

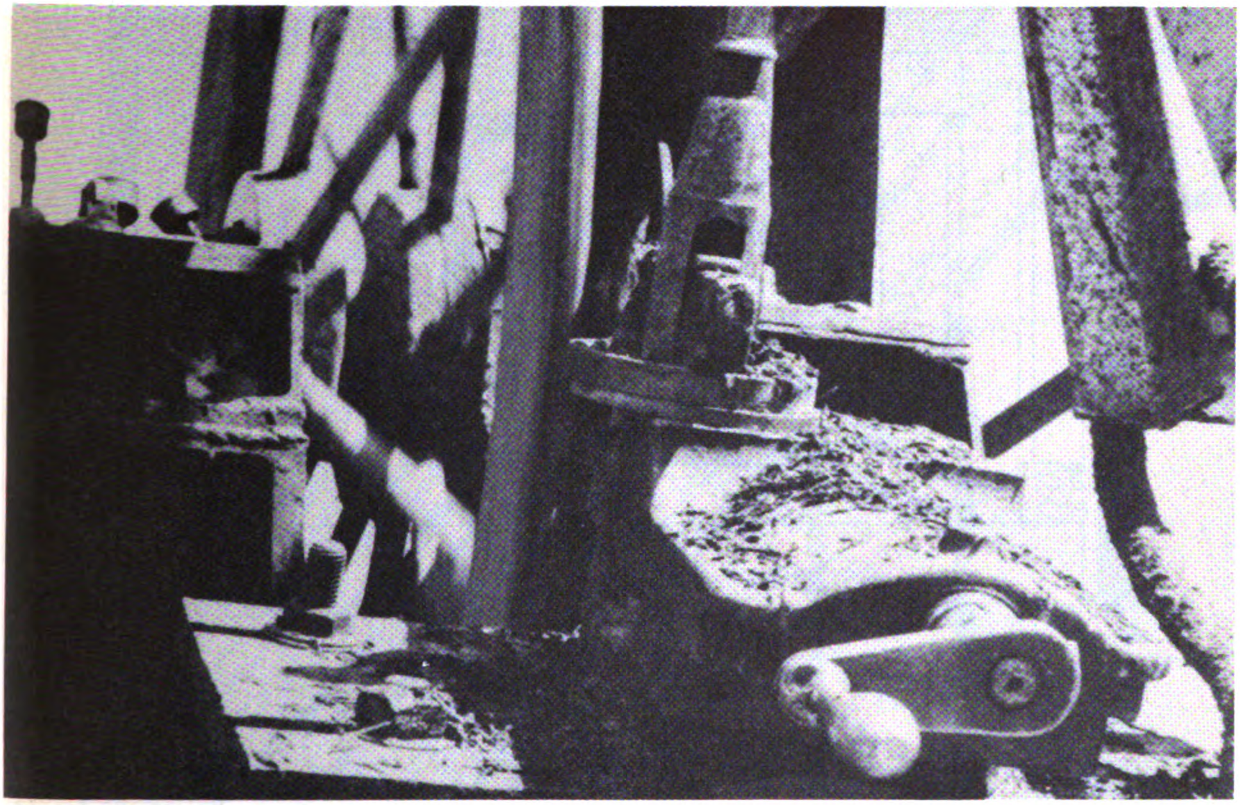


FIGURE 23. - Tool for Regrooving Head Sheave.

Underground inclined shafts are serviced by 30- to 60-hp. single-drum hoists with 1-ton skips. Loading is done either by dumping 1-ton cars directly into the skip or with a pocket and overshot arc gate. (See fig. 24.) Skips dump into ore and waste pockets, as shown in figure 25.

Auxiliary Operations

A machine shop, blacksmith shop, small pipe shop, electrical shop, timber-framing shed, and mine office are all near the shaft head. An electric-cap-lamp charging room is in the hoist house. The machine shop is equipped with welding equipment, powersaw, two drill presses, and two lathes, one of which can handle work up to 24 inches in diameter. Blacksmith-shop equipment includes an oil fired furnace and drill-steel sharpener.

Timber is stored in the mine yard. Part is cut from logs in a company sawmill at the plant, and part is delivered already cut by contractors. Approximately 3,000 bd.-ft. of lumber is lowered into the mine each day.

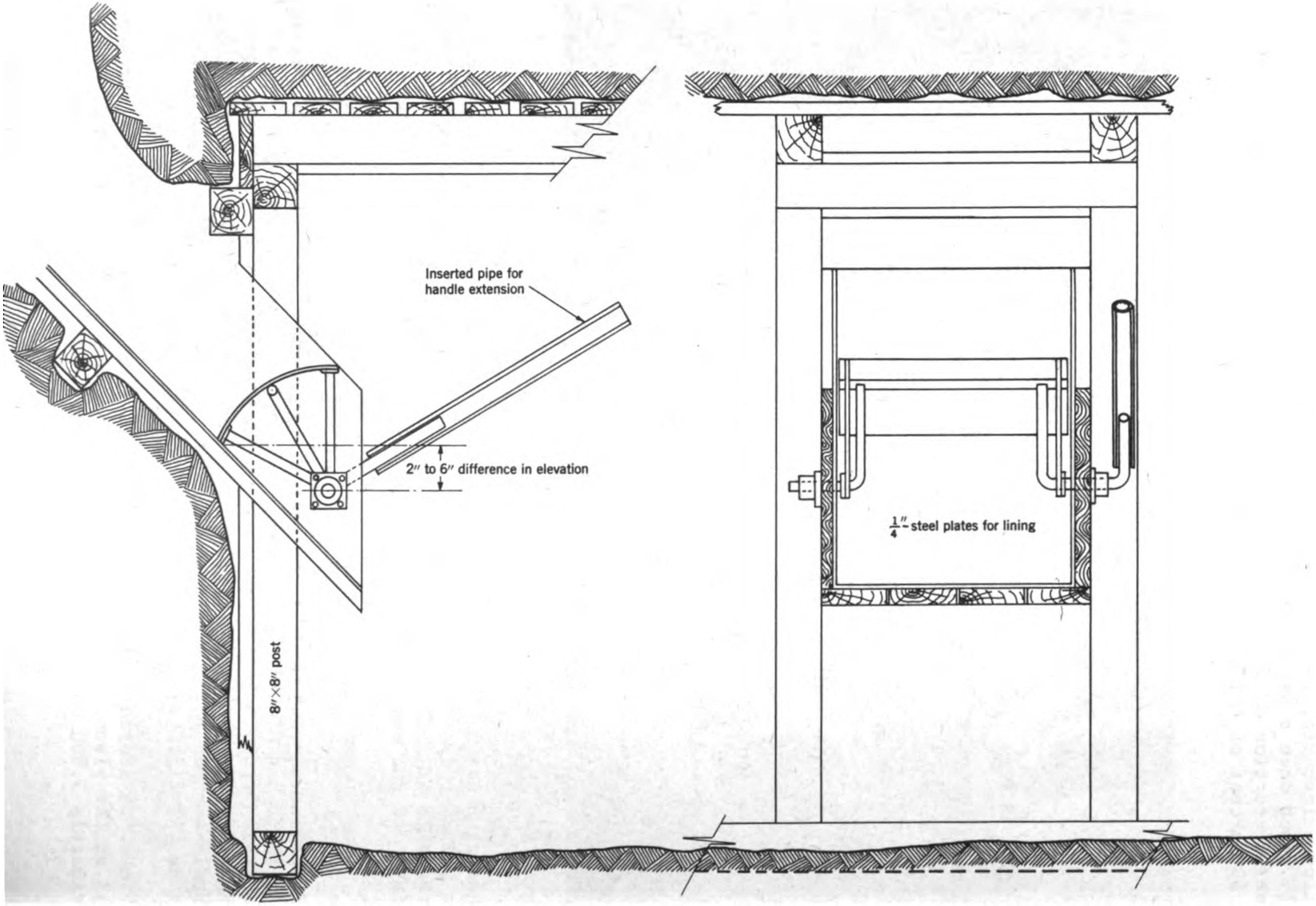

Inserted pipe for handle extension
2″ to 6″ difference in elevation
8″×8″ post
$\frac{1}{4}$″-steel plates for lining

FIGURE 24. - Arc Gate for Permanent Chutes and Pockets.

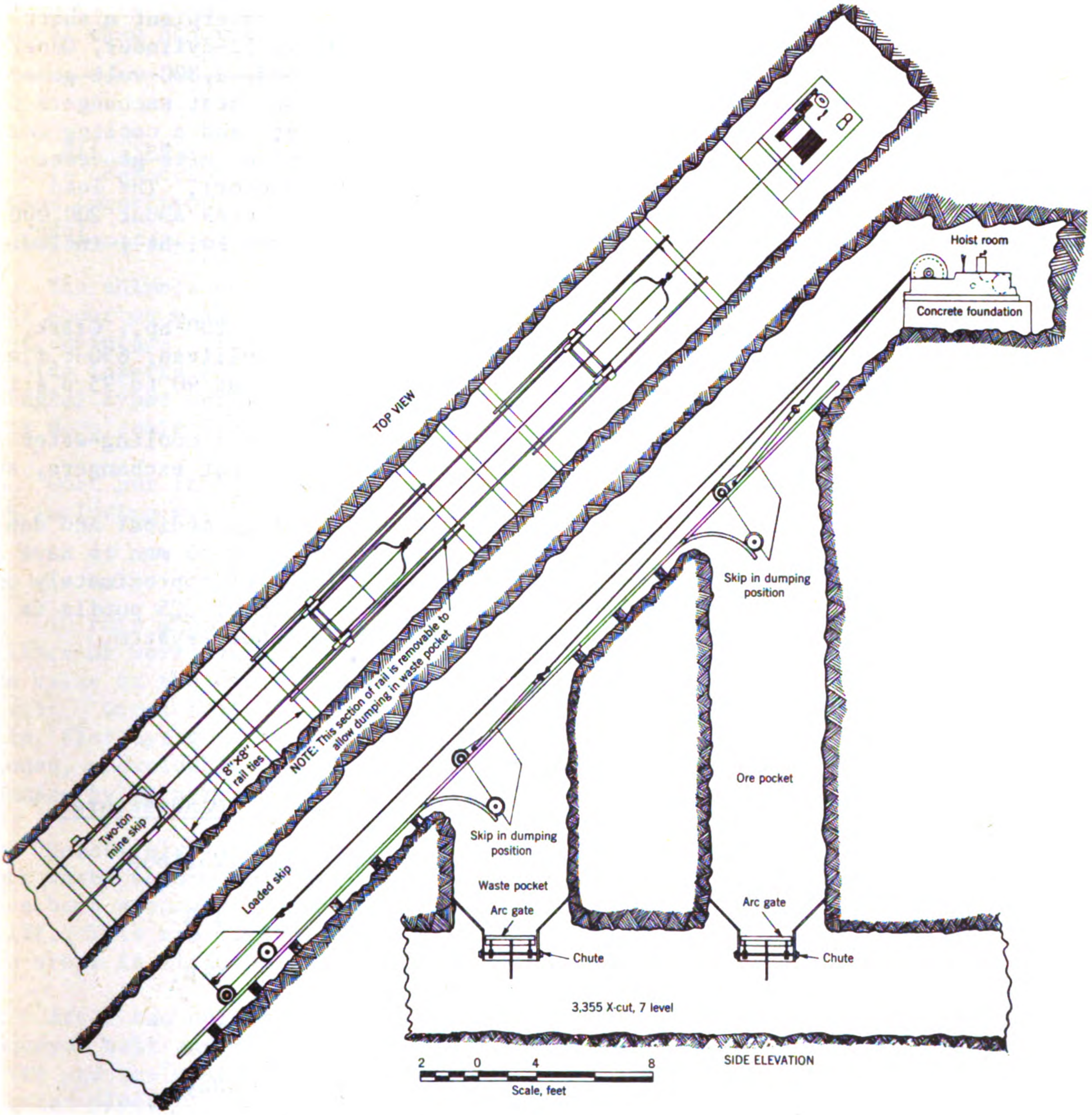


FIGURE 25. - Inclined-Winze Dumping Arrangement.

Delivery of most supplies requires 3 to 6 months or more, which necessitates carrying a large inventory of parts and supplies. The inventory is valued at about ₱900,000. Strict control of issues is maintained. Stock cards are kept up to date. Requisitions must show remaining units on hand and are completed, priced, and passed over the general manager's desk for initialing before going to the clerical department the following day.

The company maintains a 1,000-kv.-a. diesel-electric powerplant a short distance from the mine yard. The powerplant comprises two 12-cylinder, General Motors, 900-r.p.m., two-cycle engines with direct-connected, 2,300-volt generators, exciters, control panel with synchronizing equipment, heat exchangers for cooling water, various pumps for circulating cooling water, and a cooling tower. Diesel fuel is delivered to the mine by tanker truck. These units generate more than 500,000 kw.-hr. of power per month (0.8 power factor). The load varies with seasonal pumping requirements. The powerplant uses about 200,000 liters of diesel fuel per month; power costs about ₱0.05 per kw.-hr., including depreciation and overhead expenses.

The powerplant building also contains two 1,100-c.f.m., 200-hp., Clark, two-stage, double-opposed reciprocating compressors and a Sullivan, 650-c.f.m., 125-hp. L-type compressor. Air leaves the compressor plant at 90 to 95 p.s.i.

A phosphate-type water-softening agent is used to control cooling-water hardness and prevent harmful deposition of salts in pipes, heat exchangers, etc.

The mine camp includes 12 staff houses, a mess building, medical and dental facilities (Philippine law requires a mine employing over 50 men to have a resident doctor and dentist), and bunkhouse accomodations for approximately one-half the laboring force. A grade school with an enrollment of 225 pupils is sponsored by the company but administered by the public school system.

EQUIPMENT

Mine equipment not listed elsewhere includes:

	No.	Type	Manufacturer
Air drills	45	Jack-drill	Various.
Air double-drum slusher hoist	13	A4NN	I-R.
Air single-drum tugger hoists	17	EJ HK HB	G-D.
Electric hoists, UG single-drum	2	30-hp.	Joy.
	1	60-hp.	Shop-built.
Car lamps	600	P-2	MSA.
Diamond drills	1	BBS-2	Boyles.
	1	JV-55	Do.
	1	X-ray	Do.
Locomotives	6	4- to 5-ton	Shop-built.
Cars	64	1-1/2-ton	Do.
	33	1-ton	Do.
	23	1/2-ton	Do.

Original from THE OHIO STATE UNIVERSITY

Data have shown that integral tungsten carbide chisel bits are more economical than other types. Test data are summarized as follows:

Bit type	Number tested	Footage drilled	Footage per bit	Number worn out	Footage when worn out	Percent wearing out	Cause of failure
Thimble connection.....	248	459,788	1,854	29	2,484	11.7	Insert.
Thread connection.....	448	624,517	1,394	20	2,418	4.5	Thread.
Integral..............	263	473,617	1,801	85	2,030	32.3	Rod.

The thimble connection gave the best footage. As the thimble bit alone cost about as much as the integral bit and drill rod, the integral bit has a cost advantage. The thread-connected bits developed loose threads before the carbide inserts wore out. Threaded and thimble connections were crossbits. Integral types were chisel bits. Drilling speed was about equal, but integral bits were easier to remove from the hole.

Cost per foot of drilling is approximately ₱0.016 for bit and drill steel, not including servicing.

PERCENTAGE EXTRACTION AND PRODUCTION RATES

In this mine no attempt is made to leave ore. Some ore is left in caved pillars or workings where it is inaccessible and the cost of reopening exceeds the value of the ore. Ore 2 feet wide can be mined if it is average grade or better. Ore 1 foot wide must be twice the average grade to be mined profitably. Thin, flat-lying veins are difficult to mine successfully. As already mentioned, unavoidable dilution in mining reduces the grade and increases the tonnage by 20 percent.

Relatively little subsidence results if the stope is filled with coarse rock waste before the hanging wall begins to crack. Many places in the mine have been stoped to the next level with no pillar left below the floor of the drift. This can be done without interrupting train service on the level if the stope is filled promptly to the hanging wall.

After the hoisted material is washed, about 5 percent is picked off the conveyor belt and discarded as waste. Sorting is easy, because the ore is white and the waste dark gray; moreover, the waste breaks in sharper, more angular pieces.

An effort is made to mine a stope as fast as is consistent with the need for frequent filling and for having enough stopes in operation so that the variation in grade is not severe. Production per stope per day averages about 18 tons.

Table 2 gives mining efficiencies.

TABLE 2. - Mining efficiencies, Baguio Gold Mining Co.

		1956 average	1957 average
Ore per day - stoping	tons	263	301
Ore per day - development	do.	159	94
Total ore mined per day	do.	422	395
Men in stopes per day		107	127
Men in development per day		144	123
Total men - direct labor		251	250
Ore per man-shift - stoping	tons	2.5	2.4
Ore per man-shift - development	do.	1.1	.70
Development per day	feet	69.1	73.0
Development per man-shift	do.	.48	.50
Development per ton of ore mined	do.	.165	.185
Ore mined per man-shift	tons	1.28	1.35
Ore developed per foot of development	do.	7.0	5.1

COMPARISON OF METHODS USED IN DISTRICT

The methods used at Baguio Gold are similar to those used at other mines in the district; however, in the other mines wider and more steeply pitching veins predominate and are adapted to square-set mining with fill, and a higher percentage of the ore is mined by square setting elsewhere in the district than at Baguio. The grade of ore mined in 1957 approximated 0.2 ounce per ton; in fact, the economics of gold mining in the district necessitate that grade or better.

Subsidence is not noticeable on the surface unless a vein is mined to the surface, which is rare, as values usually do not go to the surface. Where mined-out veins have caved to the surface, subsidence has not created a problem, because areas overlying active mines ordinarily are not inhabitated.

MINE VENTILATION

A shop-made fan, installed at Hoover tunnel portal, helps the natural inward air current. The fan is a 7-foot-diameter centrifugal fan with curved vanes 3 feet wide by 2 feet deep, driven at 170 r.p.m. by a 30-hp. motor. Its output is approximately 8,000 c.f.m. at 0.5 inch water gage. Ventilation doors in the mine control the flow of air. Auxiliary 5-hp., 3,600-r.p.m. blowers with 10-inch Ventube are used to ventilate isolated sections of the mine.

The air in the mine is tested periodically for carbon monoxide. Generally, with the aid of compressed air, smoke clears from a working stope about one-half hour after a blast.

MINE DRAINAGE

Level 6 is the drainage level, and all water drains into the Hoover tunnel. Any water below this level must be raised by pumps. There are 13 pumps with a connected load of approximately 560 hp. The close-coupled, Bilton-type, 3,600-r.p.m. pump is used in multiple units to provide flexibility and convenience. There is no single gathering point for mine water; instead, numerous small sumps are equipped with pumps rated at 60 hp. or less. The use of many small interchangeable pumps is an operating advantage, especially when available power is limited and peak loads must be minimized. The extra operating expense of a pumping system of this type is balanced by its flexibility and dependability.

The mine water is neutral or near neutral. Standard bronze impellers with steel casings are used on all underground pumps; 4-inch pipe connected with Vitaulic couplings is used for pump columns.

The connected powerload is about double the operating load, except at the height of the rainy season. The mine produces twice as much water during the rainy season as in the dry season; water output ranges from 2,000 g.p.m. in the dry season to 4,000 to 5,000 g.p.m. in the wet season.

MILLING

The mill is near the shaft collar and has a rated daily capacity of 400 tons per day. Owing to changes in ore hardness, slimes, etc., daily capacity ranges from 350 to 500 tons per day.

The mill is essentially an all-slime cyanide plant with provision for washing slimes off the ore before crushing and floating the sulfides from the slimes and putting the slimes over blanket tables. Recent experiments have shown that, when the ore is only moderately slimy, the slimes can be fed directly into the plant after washing the ore. This procedure results in slightly better recovery and lower costs for reagents, power, and labor.

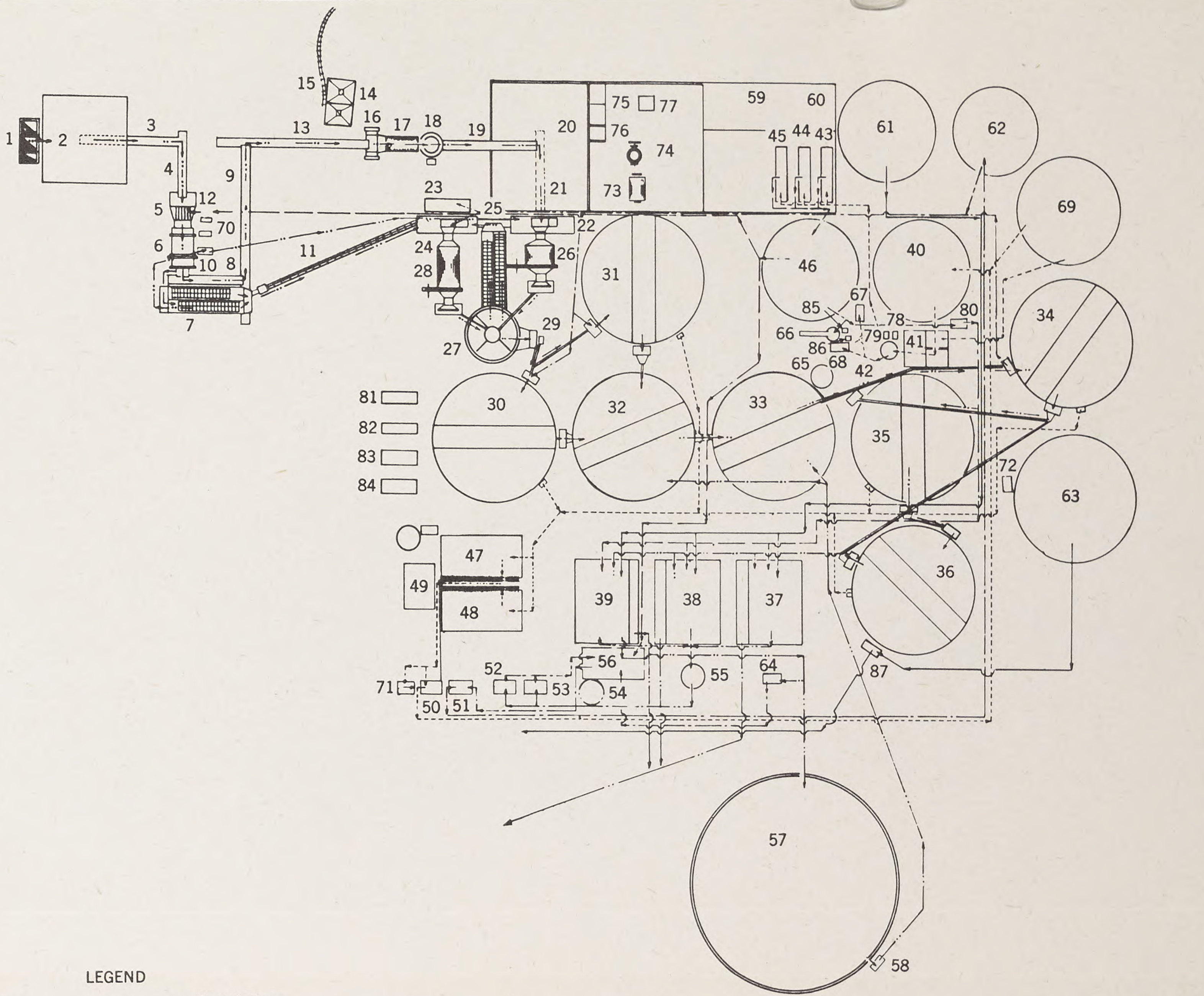
Figure 26 shows the mill layout and flowsheet. Milling statistics and costs are included under Mining and Milling Costs.

In 1957, grinding the ore to approximately 60 percent minus-200-mesh and adding 0.81 pound CaCn per ton resulted in an overall recovery of 93.6 percent. During the year 10.6 tons per man-shift was milled. Water for milling, approximately 150 g.p.m., is obtained from the Antamok River, except during the dry season when it comes from the mine.

INCENTIVE WAGE SYSTEM

Insofar as possible, everyone in the mine is given an incentive wage. When it is difficult to measure or establish a unit price, a small bonus of 5 to 10 percent of the base wage is given; the bonus is revocable if work of any individual or group is unsatisfactory. This bonus is called an efficiency bonus and is greatly appreciated by the workers. It helps in enforcing cleanup and reasonable work output.

Table 3 shows current contract prices. Base wages are always paid, and the bonus is calculated semimonthly and paid monthly. Bonus calculations are based on number of shifts charged against a working place compared with work



LEGEND

No.	Description
1.	Mine shaft
2.	Coarse bin, 360-ton capacity, 20′×20′×23′6″
3.	No. 1 conveyor, 24″× 4 ply, 76′ long
4.	No. 2 conveyor, 24″× 4 ply, 72′ long
5.	Grizzly, 24″
6.	Telsmith superscrubber, 60″×9′
7.	Dorrco type DSF duplex heavy duty drag classifier, 6′×20′
8.	No. 3 conveyor, 24″× 4 ply, 43′ long
9.	No. 4 conveyor, 24″× 4 ply, 124′ long
10.	Washing plant slime pump, SRL 5×5, 15-hp. motor,738-28 r. p. m.
11.	Half-ton skip for (7 above) discharge to No. 2 ball mill
12.	Solution pump, Peerless type, model 3×4×10
13.	No. 5 conveyor, 24″× 4 ply, 109′ long
14.	Waste bin, 6′×12′ steel
15.	Waste tram for 1/2-ton car to dump
16.	Telsmith roller-bearing jaw crusher, 14″×24″
17.	Telsmith Vibro-King vibrating screen, 3′×8′
18.	Telsmith gyrasphere, crusher 36 S
19.	No. 6 conveyor, 18″× 4 ply, 66′ long
20.	Fine-ore bin, 740-ton capacity, 24′×30′×20′
21.	No. 7 conveyor, 18″× 4 ply, 46′ long
22.	Scoop box to No. 1 ball mill
23.	Lime mixer
24.	Scoop box to No. 2 ball mill
25.	Classifier discharge launder to ball-mill scoops
26.	Primary ball mill, Traylor, 7′×5′
27.	Dorr bowl classifier, turret-type, 12′8″ dia., 29′8″×6′ tank
28.	Secondary ball mill, Allis-Chalmers, 5′×10′
29.	Primary pump, Canadian A-C SRL 5×5, 5-hp. motor,600 r. p. m., 20′ hd.
30.	Primary thickener No. 1, Dorr tray type, 30′ dia. × 12′
31.	Primary thickener No. 2, Dorr tray type, 30′ dia. × 15′
32.	Agitator No. 1, Dorr type, 30′ dia. × 20′
33.	Agitator No. 2, Dorr type, 30′ dia. × 20′
34.	Secondary thickener No. 1, Dorr tray type, 30′ dia. × 15′
35.	Secondary thickener No. 2, Dorr tray type, 30′ dia. × 12′
36.	Secondary thickener No. 3, Dorr tray type, 30′ dia. × 12′
37.	Filter No. 1, continuous vacuum type, 14′×18′
38.	Filter No. 2, continuous vacuum type, 14′×18′
39.	Filter No. 3, continuous vacuum type, 14′×18′
40.	Pregnant-solution storage tank, 24′ dia. × 10′
41.	Weir measuring tank
42.	Crowe vacuum tower
43.	Precipitation press No. 1, Merrill plate and frame
44.	Precipitation press No. 2, Merrill plate and frame
45.	Precipitation press No. 3, Merrill plate and frame
46.	Barren-solution storage tank, 24′ dia. × 10′
47.	Clarifying tank No. 1, Butters type, 42 leaves, 19′4″×9′7″×9′
48.	Clarifying tank No. 2, Butters type, 42 leaves, 19′4″×9′7″×9′
49.	Clarifier leaf-cleaning platform
50.	Pregnant-solution pump
51.	Mill-solution pump
52.	Filtrate pump
53.	Filtrate pump
54.	Vacuum moisture-trap tank with Peerless pump, 5-hp. motor, 245 r. p. m.
55.	Filtrate receiver
56.	Filtrate sump tank
57.	Mill sump, 50′ dia. × 10′ concrete tank
58.	Sump pump, Canadian A-C SRL 5×5, 10-hp. motor, 920 r. p. m.
59.	Mill bodega
60.	Mill-staff toilet
61.	Water-storage tank, 24′ dia. × 10′
62.	Mill-solution storage tank, 20′ dia. × 15′
63.	Rain-water tank for powerplant 21′6″ dia. × 8′
64.	Slime pump, Kimball-Krough, centrifugal 3″, solid-lined 15-hp. motor, 1,200 r. p. m.
65.	Cyanide feeder
66.	Zinc-belt feeder, Merrill
67.	Precipitation pump No. 1, Peerless centrifugal, 20-hp. motor, 1,760 r. p. m.
68.	Precipitation pump No. 2, Peerless centrifugal, 30-hp. motor, 1,760 r. p. m.
69.	Pregnant-solution concrete storage tank, 24′ dia. × 8′
70.	Washing plant water pump, Peerless centrifugal, 7.5-hp. motor, 1,800 r. p. m.
71.	Pregnant-solution pump No. 2, Peerless 15-hp. motor, 1,745 r. p. m.
72.	Mill water pump, Byron Jackson centrifugal, 7.5-hp. motor, 3,500 r. p. m.
73.	Melting furnace, Lindberg-Fisher, type 93
74.	DFC melting furnace, tilting-type, No. 275
75.	Precipitate drying furnace
76.	Refinery vault
77.	Slug-pouring pit
78.-79.	Precipitation vacuum pumps
80.	Barren-solution pump
81.-82.	Mill air compressors Nos. 1-2, size 7.5×5, W.P. 50 lb.
83.-84.	Mill vacuum pumps Nos. 1-2
85.-86.	Zinc emulsion and barren-solution supply pumps
87.	Water pump to powerplant, 2-hp. G. E. motor, 1,735 r. p. m.

FIGURE 26. - Schematic Drawing, Mill Flowsheet.

units produced times unit price in the schedule. If work units produced times unit price is greater than the cost of labor charged against the working place, the resulting bonus is shared among those working in that place. Usually all men under a capataz are in the same bonus group, even if several working places are included. This system permits flexibility in assigning work with a minimum of paperwork. The capataz also shares equally in the bonus.

The schedule of contract prices is revised as necessary. Generally the bonus runs from 5 to 50 percent of the base wage; 25 percent is a good mine average. The management feels that an incentive wage of this type encourages a desirable working attitude.

Table 4 shows the average number of employees in 1956 and 1957. Of the 730 employees of Baguio Gold, all but 3 are Filipino citizens. The Filipino miner is adaptable and willing and generally feels a sense of responsibility for his job. The average weight of a miner is 120 pounds and his average height is 5 feet 3 inches; thus, many jobs performed by a single worker elsewhere require two men at Baguio Gold. Labor unionism is fairly well developed and is becoming more popular. On the whole, the labor situation in the Philippines compares favorably with that in other parts of the world.

TABLE 3. - Schedule of contract prices, Baguio Gold Mining Co.

STOPING

Hand mucking:		
Breaking, timbering, and mucking for 30 feet	per cubic foot	₱0.144
Mucking 30 to 60 feet - ₱0.10 + ₱0.05	do.	.15
Mucking 60 to 90 feet - .10 + .08	do.	.18
Mucking 90 to 120 feet - .10 + .11	do.	.21
Mucking with scraper or other mechanical means:		
Breaking, timbering, and mucking 30 feet	do.	.144
Mucking 30 to 60 feet - ₱0.10 + ₱0.02	do.	.12
Mucking 60 to 90 feet - .10 + .03	do.	.13
Mucking 90 to 120 feet - .10 + .04	do.	.14
Hand tramming to ore pass with distance of 500 feet	do.	.024
Tramming fill from transfer chutes with distance of 500 feet	do.	.024
Stope and raise preparation:		
Including drift timber	per foot	₱4.74
Not including drift timber	do.	3.18
Timbered drift with bridge cap	do.	1.56
Sublevel: Breaking (5 by 5 feet)	per cubic foot	₱0.192

DEVELOPMENT

Dogholes:		
Drift dogholes 0 to 15 feet	per foot	₱2.95
15 to 25 feet	do.	4.00
25 feet on	do.	5.05
Stope dogholes 0 to 15 feet	do.	2.20
15 feet on	do.	2.95

TABLE 3. - Schedule of contract prices, Baguio Gold Mining Co. (Con.)

Glory hole for fill:		
Breaking	per cubic foot	₱0.04
Mucking and cleaning	do.	₱0.01 - 0.036
Driving 6- by 8-foot or 5- by 7-foot drifts and crosscuts:		
Hand mucking	per foot	₱8.40
Mucking machine	do.	7.92
Timbering 7- by 8-foot drift	do.	2.16
Additional cost per foot of advance for extra tramming distance of 250 feet is ₱0.15 for every 500 feet.		
Driving with selective mining (double blasting)	do.	10.80
Driving with selective mining with mucking machine	do.	9.60
Stope and raises:		
Breaking ore in vein less than 5 feet wide	per square foot	₱0.564
Breaking ore - 4 feet wide without mucking - 0 to 30 feet pay by square feet; breaking ore - 4 feet wide with mucking - 30 to 60 feet pay by cubic foot.		
Note: This price includes timbering, cleaning, and mucking.		
Filling stopes: For mucking distance of 30 feet	per cubic foot	₱0.03
Raising (cribbed) (3.5- by 7.5-foot):		
Breaking in ore	per foot	₱2.55
Breaking in wall rock	do.	3.20
Hand tramming	per cubic foot	.02
Timbering 0 to 50 feet	per foot	1.60
50 to 100 feet	do.	2.25
100 to 150 feet	do.	2.40
150 to 200 feet	do.	2.60
Raising (cribbed) (3.5- by 10-foot):		
Breaking in ore	per foot	₱3.40
Hand tramming 500 feet	per cubic foot	.02
Timbering 0 to 50 feet	per foot	2.03
50 to 100 feet	do.	2.86
100 to 150 feet	do.	3.05
150 to 200 feet	do.	3.30
Raising with irregular sets:		
Breaking, timbering, and mucking for 30 feet	per cubic foot	₱0.12
Mucking 30 to 60 feet - ₱0.10 + ₱0.05	do.	.15
Mucking 60 to 90 feet - .10 + .08	do.	.18
Mucking 90 to 120 feet - .10 + .11	do.	.21
Hand tramming 500 feet	do.	.02
Shaft sinking:		
Breaking and mucking (three-compartment)	per foot	₱100.00
Timbering (shafts similar to San Pablo)	do.	20.00
Winze sinking (6- by 8-foot):		
Breaking and mucking	per foot	₱25.00
Timbering	do.	10.00
Breaking, mucking, and timbering (5 by 12 feet)	do.	43.75

TABLE 3. - Schedule of contract prices, Baguio Gold Mining Co. (Con.)

Winze sinking (6- by 8-foot) (Con.):		
Winze (M-7-3355) - breaking, timbering, mucking, pumpmen, hoistmen, trackmen, and all other services except electrical	per foot	₱80.00
Note: Any month in which advance is less than 45 feet there will be a 30-percent reduction in price.		

TIMBER REPAIRS

Repairs:		
Irregular sets over drift (empty)	per cubic foot	₱0.06
Irregular sets in caved ground	do.	.096
Doubling sets	each	7.95
Ladders	do.	1.00
Pigsty	per cubic foot	.06
Changing ordinary ground:		
Bridges	each	₱2.10
Braces - collar, scab	do.	.65
Caps, long	do.	5.60
Caps, standard	do.	3.95
Cribbing	do.	1.00
Post - angle	do.	.65
Post - drift	do.	2.65
Lagging (side, top, flooring and gob)	per panel	.85
Set	each	9.00
Stripping drift sets including miscellaneous timbers	do.	3.00
Building constructions as paid by bonus:		
Floor area	per square foot	₱0.75
Note: This price is for carpentry job only.		
Ventilation door	each	9.85

ASSESSMENT

Assessment tunnel (4- by 6-foot) 0 to 15 feet	per foot	₱2.95
15 to 25 feet	do.	4.00
25 feet on	do.	5.05
Assessment trench	per cubic foot	.08
Assessment trail (new trail)	per foot	.035
Assessment trail (brushing old trail)	do.	.02

TIMBER REPAIRS

Changing:		
Raise - stripping	per foot	₱1.50
Raise - retimbering 0 to 50 feet	do.	1.60
50 to 100 feet	do.	2.25
100 to 150 feet	do.	2.40
150 to 200 feet	do.	2.60

TABLE 3. - Schedule of contract prices, Baguio Gold Mining Co. (Con.)

Changing (Con.):		
Raise - recribbing (timber over 6 by 8 feet) 2- or 3-inch	per foot	₱3.95
Raise - recribbing (timber over 6 by 8 feet) cribbing	do.	4.65
Shaftbearer sets	each	13.20
Dividers	do.	3.95
End plates	do.	7.10
Panel lagging	do.	1.35
Platform manway	do.	1.35
Post	do.	3.30
Timbering (retimber)	per foot	17.00
Set (retimber)	each	103.35
Set close to station (transition to drift sets; long caps, 10-foot; long posts, 10-foot)	do.	13.20
Station posts (14 feet long)	do.	6.60
Station sets (long post, 10- or 12-foot; long caps 12- by 14-foot)	do.	19.80
Wall plates	do.	15.95
TIMBER, MISCELLANEOUS		
Bulkheading chutes and manways	each	₱3.95
Chutes including butt caps	do.	13.20
Flume	per foot	0.30 - .55
Hoist platform	each	6.60
Raise - lining 1 side with 2-inch boards	per foot	.18
Raise - lining 2 sides with 2-inch boards	do.	.20
Raise - lining 4 sides with 2-inch boards	do.	.40
Raise - lining 4 sides with 3-inch boards	do.	.65
Sills	each	3.95
Slide, timber	per foot	.18
Staging and staggering ladders	do.	.35
Storage or passway grizzly	each	.60
Special square sets	per cubic foot	.03
Temporary chute	each	4.00
Boring hole for pipe hanger	do.	.20
Salvaging ladders	do.	.50
Toolbox	do.	6.00
Stringer - large	do.	5.60
Stringer - small	do.	3.95
Stull - upright	do.	2.65
Stull - cross, large	do.	1.35
Stull - small	do.	1.00
Rehabilitation of 2150 winze - mucking and timbering	per cubic foot	.32

TABLE 3. - Schedule of contract prices, Baguio Gold Mining Co. (Con.)

MISCELLANEOUS

Ditching	per foot	₱0.18 - ₱0.35
Slabbing out ground for station and switches (drilling, breaking, and mucking)	per cubic foot	.10
Salvaging chutes and bulkheading	each	6.60
Widening - breaking and mucking	per cubic foot	.10

REHABILITATION

Hand mucking	per cubic foot	₱0.072
With machine	do.	.024
Hand mucking above drift	do.	.024
Top spiling	each	.50
Side spiling	do.	.30
Rehabilitating full drift with drift timber	per cubic foot	.144

TABLE 4. - Number of employees, Baguio Gold Mining Co.[1/]

(Average number on payroll - including staff)

	1956	1957		1956	1957
Accounting:			Personnel	2	2
Main office	11	11	Safety	4	5
Warehouse	5	5	Mess (guesthouse)	1	1
Engineering:			Mine:		
Surveying	13	14	Underground	428	440
Diamond drilling	11	13	Surface	29	29
Sampling	8	8	Machine shop	32	32
Assessment	6	8	Outside:		
Total	54	59	Bull gang	11	7
Mill	46	46	Carpenter	5	7
Electrical	14	12	Gardener	1	1
Police	32	32	Transportation	2	1
Powerhouse	9	7	Pipe and track (underground and surface)	23	26
Medical	6	7			
Assay	6	6	Total	705	720

[1/] The minimum base wage in the Philippines for industrial projects is ₱4.00 per day. At Baguio Gold, various incentive payments increase the base wage by 5 to 50 percent. The average wage of underground workers is approximately ₱5.75. The average wage of surface workers is approximately ₱4.20.

SAFETY METHODS

The Safety Department comprises a safety engineer, three safety inspectors (one on each shift), and a clerk. The safety inspectors are required, insofar as possible, to visit all places where men are working each shift. At the end

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of the shift they must fill out and sign a report (fig. 27), noting the condition of each working place and recommending any corrective action needed. These reports are reviewed and summarized (see fig. 28) by the safety engineer each morning and passed to the mine superintendent and general manager. Even minor accidents are noted.

The safety engineer, safety inspectors, and mine bosses (except the shift boss) receive a safety bonus depending upon the number of lost-time accidents in a month. If there are no lost-time accidents, the bonus of each mine boss is doubled. A mine boss' safety bonus is based on the number of man-shifts he supervised without an accident and runs from 3 to 8 percent of his base wage. It is cancelled if there is a lost-time accident or avoidable unsafe condition on his beat. The inspectors and safety engineer also receive safety bonuses that increase their wages about 50 percent in a month of no lost-time accidents. Their bonuses are reduced 25 percent for each lost-time accident. Constant vigilance is maintained to ascertain that all accidents are reported, and any violation results in cancellation of the bonus. Table 5 shows frequency and severity records from 1954 through 1957.

TABLE 5. - Accident statistics, Baguio Gold Mining Co.

	1954	1955	1956	1957
Accidents:				
No-lost-time.................	39	28	17	47
Lost-time, nonfatal..........	43	29	35	20
Fatal........................	0	2	3	2
Days lost..........................	349	12,273	18,300	12,931
Man-hours worked..................	1,697,632	1,615,009	1,748,775	1,776,282
Frequency rate.....................	25.33	19.19	21.72	12.38
Severity rate......................	.21	7.59	10.46	7.27

MINING AND MILLING COSTS

Milling supply costs have increased in 1957, owing to rising costs and increased import duties. The increase has been partly offset by an increase in labor efficiency. Grinding-ball consumption was lowered in 1957 by using more small (2-1/2-inch) balls and increasing the specific gravity of the ball-mill discharge. Flotation was discontinued in 1957; however, eliminating consumption of flotation reagents was counterbalanced to some extent by increased consumption of aerofloc.

Tables 6 through 18 give data on performance and costs of mining and milling, consumption of supplies, and general operating statistics.

BAGUIO GOLD MINING COMPANY
Safety Department

Safety Inspection Shift Report Inspector:________________ Shift:________ Date:__________

Place	Time Visited	Barred Down	Timbered?	Clean?	Tools O.K.?	Safety Condition	Recommendations

Following shift should watch:________________ Accidents this shift:__________ Signed:______________

(Reverse side)

Description of accident:____

Name:____ Chapa No.:__________

Time:________________ Place:____________________________________

What happened:____

____

Extent of injury:____

____
Safety Inspector

FIGURE 27. - Safety Department Inspector's Shift Report.

BAGUIO GOLD MINING COMPANY
Safety Department

Daily Safety Inspection

__________________, 195__

"A" Shift Inspector:____________________ Remarks:____________________

____

____

____

"B" Shift Inspector:____________________ Remarks:____________________

____

____

____

"C" Shift Inspector:____________________ Remarks:____________________

____

____

____

General Remarks:____

____

____

____

Description of accident:_________________________ Name:______________

Chapa No.:__________ Time:__________ Place:____________________

What happened:____

____

Extent of injury:____

____

____
Safety Engineer

FIGURE 28. - Safety Engineer's Daily Report.

TABLE 6. - Mill statistics, Baguio Gold Mining Co.

	1954	1955	1956	1957
Ore milled..............................tons	137,232	144,369	150,576	138,951
Gold shipped........................ounces	29,582	26,299	30,488	29,463
Average recovery...................percent	91.77	90.75	91.83	93.63
Average milled per day................tons	376	396	413	381
Average men working per day (including supervision)..................	51.05	42.85	38.75	36.0
Average milled per man-shift..........tons	7.37	9.24	10.68	10.58
Average cost per ton milled...............	₱3.42	₱3.29	₱3.34	₱3.37

TABLE 7. - Average consumption of mill supplies, Baguio Gold Mining Co.

	1954	1955	1956	1957
Cyanide....................pounds per ton milled	0.92	0.83	0.75	0.81
Lime..................................do.	4.61	2.60	2.78	3.47
Zinc dust.............................do.	.26	.20	.23	.24
Grinding balls........................do.	1.24	1.24	1.39	.93
Pine oil..............................do.	.032	.037	.031	.038
Xanthate Z-6..........................do.	.009	.005	.004	.006
Reagent 301...........................do.	.008	.006	.005	.006
Pine oil..................pounds per ton floated	.373	.621	.520	.481
Xanthate Z-6..........................do.	.076	.088	.074	.072
Reagent 301...........................do.	.081	.095	.079	.078
Aerofloc..................pounds per ton milled	-	-	.006	.0146

TABLE 8. - Average consumption of refinery supplies, Baguio Gold Mining Co.

	1954	1955	1956	1957
Precipitate......................kilograms	9,065.0	8,252.6	8,831.2	8,032.50
Soda ash......pounds per kilo precipitated	.99	.67	.50	.59
Borax glass...............do.	.48	.58	.76	.77
Niter.....................do.	.18	.07	-	-
Hematite..................do.	-	.12	.22	.22
Silica....................do.	.20	-	-	-
Manganese dioxide.........do.	-	.09	.18	.18
Carbofrax lining..........do.	.77	1.04	.54	.54
Crude oil ....liters per kilo precipitated	1.34	1.58	2.13	2.23

TABLE 9. - Cost statistics, pesos per ton milled[1]

	1956	1957
Operating expenses:[2]		
Mining - direct	₱7.57	₱9.84
Milling	3.34	3.37
Marketing	.36	.40
Mine products tax	.35	.40
General overhead - mine	1.93	2.41
General overhead - Manila	.47	.59
Less cost of 3 bars not shipped	-	-.23
Total	14.02	16.78
Mining, direct:[2]		
Labor (including bonus and supervision)	3.77	4.55
Timber	1.25	1.85
Explosives	.52	.75
Supplies	1.10	1.49
Mining (operating development charges)[3]	.82	1.08
Miscellaneous	.11	.12
Total	7.57	9.84
Milling:		
Supervision	.19	.20
Labor	.48	.49
Supplies	1.08	1.19
Distributive accounts	.16	.15
Power	1.00	.94
Miscellaneous	.43	.40
Total	3.34	3.37

[1] ₱ - Philippine pesos officially valued at ₱2.00 = $1.00.

[2] Does not include waste mined (see table 10).

[3] All stope development is considered operating development and is a part of direct mine expense.

TABLE 10. - Tons mined, man-shifts, and tons mined per man-shift

Tons mined

	Stopes	Operating development[1]	Capital development[2]	Rehabilitation	Total
Ore:					
1956	95,627	44,262	13,892	102	153,883
1957	109,113	26,821	6,867	277	143,078
Waste:					
1956	1,586	5,057	42,230	2,049	50,922
1957	6,847	12,776	50,764	5,367	75,754
Ore and waste:					
1956	97,213	49,319	56,122	2,151	204,805
1957	115,960	39,597	57,631	5,644	218,832

See footnotes at end of the table.

TABLE 10. - Tons mined, man-shifts, and tons mined per man-shift (Con.)

Man-shifts

	Stopes	Operating development 1/	Capital development 2/	Rehabilitation	Total
Mine, direct:					
1956..........	37,755	25,380	29,459	-	92,594
1957..........	43,578	20,030	25,052	-	88,660
Mine, indirect:					
1956..........	22,735	15,313	16,397	-	54,445
1957..........	32,906	14,746	14,814	-	62,466
Surface, indirect:					
1956..........	5,494	3,861	3,946	-	13,301
1957..........	5,748	2,733	2,570	-	11,051
Total:					
1956..........	65,984	44,554	49,802	-	160,340
1957..........	82,232	37,509	42,436	-	162,177

Tons per man-shift

Ore:					
1956..........	1.45	0.99	0.28	-	0.96
1957..........	1.33	.71	.16	-	.88
Waste:					
1956..........	.02	.11	.85	-	.32
1957..........	.08	.34	1.20	-	.47
Ore and waste:					
1956..........	1.47	1.10	1.13	-	1.28
1957..........	1.41	1.05	1.36	-	1.35

1/ Operating development is stope-preparation development: Raises, sublevels, etc.

2/ Capital development is major development: Drifts, crosscuts, shafts, etc.

TABLE 11. - Average consumption of mine supplies 1/

	Timber, bd. ft. per ton	Dynamite lb. per ton	Fuse, ft. per ton	Blasting caps, number per ton
Stoping:				
1956.................	6.2	0.57	3.8	0.7
1957.................	8.8	.49	3.5	.6
Operating development: 2/				
1956.................	12.9	1.19	7.2	1.3
1957.................	15.1	1.08	6.9	1.2
Capital development: 2/				
1956.................	8.3	1.4	7.0	1.2
1957.................	6.9	1.3	6.9	1.2
Total:				
1956.................	8.3	.9	5.4	1.0
1957.................	9.5	.8	4.9	.9

1/ Kilowatt-hours per ton treated in 1956 was 30.9 and in 1957 was 29.2; 2,550 c.f.m. of compressed air was available at the mine in 1956 and 2,800 c.f.m. in 1957.

2/ Capital development is major development: Drifts, crosscuts, shafts, etc. Operating development is stope-preparation development: Raises, sublevels, etc.

TABLE 12. - Average stoping (including distributive and service accounts) and development costs

Stoping cost per ton (including distributive and service accounts)

	1955 (106,381 tons)1/	1956 (97,213 tons)1/	1957 (115,960 tons)1/
Labor......................	₱3.46	₱3.25	₱3.44
Timber.....................	1.24	1.00	1.42
Explosives.................	.48	.40	.53
Miscellaneous supplies......	.57	.98	1.12
Other charges..............	1.22	2.41	2.17
Total.................	6.97	8.04	8.68

Development costs (capital and operating)

	1955		1956		1957	
	Cost per foot (18,443 ft.)	Cost per ton broken (39,568 tons)2/	Cost per foot (24,278 ft.)	Cost per ton broken (105,441 tons)2/	Cost per foot (23,990 ft.)	Cost per ton broken (97,228 tons)2/
Labor........	₱18.73	₱8.73	₱19.24	₱4.43	₱17.55	₱4.33
Timber.......	7.14	3.31	7.13	1.64	6.93	1.71
Explosives...	4.16	1.93	3.78	.87	4.75	1.17
Miscellaneous supplies....	4.33	2.02	7.52	1.73	8.73	2.15
Other charges	6.25	2.94	14.92	3.43	10.42	2.45
Total...	40.61	18.93	52.59	12.10	48.38	11.81

1/ Tons of ore and waste mined from stopes (see table 10 for 1956 and 1957).

2/ Includes waste and ore under operating and capital development (see table 10 for 1956 and 1957.

TABLE 13. - Average mining costs - stoping

Monthly average

		1956	1957
Ore..	tons	7,969	9,092
Waste......................................	do.	132	570
Total................................	do.	8,101	9,662
Direct man-shifts................................		3,146	3,631
Indirect man-shifts..............................		2,352	3,221
Total man-shifts............................		5,498	6,852
Tons per man-shift...............................		1.47	1.41

Cost per ton

	1956			1957		
	Direct	Indirect	Total	Direct	Indirect	Total
Labor..................	₱1.69	₱1.26	₱2.95	₱1.71	₱1.42	₱3.13
Timber.................	.75	.33	1.08	.95	.47	1.42
Explosives.............	.35	-	.35	.54	-	.54
Supplies...............	.14	.75	.89	.22	.91	1.13
Total.............	2.93	2.34	5.27	3.42	2.80	6.22
Percent of grand total.	56	44	100	55	45	100

TABLE 14. - Average mining costs - raising
(Nominal raise, 4 by 8 feet)

Monthly average

		1956	1957
Advance	feet	664	834
Ore	tons	451	1,040
Waste	do.	2,301	2,192
Total	do.	2,750	3,232
Direct man-shifts		1,485	1,623
Indirect man-shifts		1,044	1,385
Total man-shifts		2,529	3,008
Tons per man-shift		1:1	1:1
Feet per man-shift		0.26	0.28

Cost per foot

	1956			1957		
	Direct	Indirect	Total	Direct	Indirect	Total
Labor	₱9.67	₱6.99	₱16.66	₱8.99	₱7.65	₱16.64
Timber	9.24	1.93	11.17	6.62	2.34	8.96
Explosives	3.30	-	3.30	4.22	-	4.22
Supplies	2.07	4.26	6.33	2.87	4.69	7.56
Total	24.28	13.18	37.46	22.70	14.68	37.38
Percent of grand total	65	35	100	61	39	100
Labor, percent of each total	40	53	44	40	52	45

TABLE 15. - Average mining costs - drifts and crosscuts
(Nominal drift and crosscut, 7 by 5 feet)

Monthly average

		1956	1957
Advance	feet	1,014	1,134
Ore	tons	1,313	570
Waste	do.	2,974	4,136
Total	do.	4,287	4,706
Direct man-shifts		2,166	1,798
Indirect man-shifts		1,261	1,524
Total man-shifts		3,427	3,322
Tons per man-shift		1.3	1.4
Advance per manshift	feet	.30	.33
Ratio of cost timbered to cost untimbered		5.2:1	3.2:1

Cost per foot

	1956			1957		
	Direct	Indirect	Total	Direct	Indirect	Total
Labor	₱9.05	₱6.31	₱15.36	₱7.62	₱6.18	₱13.81
Timber	4.80	1.93	6.73	3.32	1.98	5.29
Explosives	3.62	-	3.62	5.10	.01	5.11
Supplies	3.25	2.64	5.89	2.74	3.84	6.58
Total	20.72	10.88	31.60	18.78	12.01	30.79
Percent of grand total	65	35	100	61	39	100
Labor, percent of total	44	58	49	41	51	4

TABLE 16. - Average mining costs - sublevels
(Nominal sublevels, 6 by 4 feet)

Monthly average

		1956
Advance	feet	708
Ore	tons	1,579
Waste	do.	242
Total	do.	1,821
Direct man-shifts		1,362
Indirect man-shifts		1,124
Total man-shifts		2,486
Tons per man-shift		.73
Advance per man-shift	feet	.28

Cost per foot

	1956		
	Direct	Indirect	Total
Labor	₱8.45	₱7.22	₱15.67
Timber	4.92	1.60	6.52
Explosives	3.67	-	3.67
Supplies	1.45	2.86	4.31
Total	18.49	11.68	30.17
Percent of total	61	39	100
Labor, percent of total	46	62	52

TABLE 17. - Direct mining costs - diamond drilling
(EX and XR sizes)

	1956	1957
Average man-shifts per month	308	394
Average feet drilled per month	1,565	1,159
Average feet per man-shift	5.08	2.94
Average feet per drill-shift	10.00	6.03

	1956			1957		
	Labor	Supplies	Total	Labor	Supplies	Total
Cost per foot	₱0.92	₱1.36	₱2.28	₱1.56	₱3.06	₱4.62
Percent of total	40	60	100	34	66	100

TABLE 18. - Summation of costs per ton of ore mined

	Man-shifts worked	Labor	Timber	Explo- sives	Sup- plies	Miscel- laneous	Sub- total	Service charges	Total costs
Development:									
1955.................	0.27	₱1.44	₱0.36	₱0.31	₱0.30	₱0.17	₱2.58	₱0.27	₱2.85
1956.................	.34	1.96	.54	.35	.81	.10	3.76	.40	1/4.16
1957.................	.34	1.98	.53	.50	1.02	.03	4.06	.46	4.52
Mining direct:2/									
1955.................	.74	3.78	1.30	.60	.62	.29	6.59	.74	7.33
1956.................	.68	3.68	1.23	.51	1.08	.09	6.59	.81	7.40
1957.................	.78	4.42	1.80	.73	1.44	.12	8.51	1.05	3/9.56
Milling:									
1955.................	.10	.66	-	-	.79	.67	2.12	1.10	3.22
1956.................	.10	.65	-	-	1.06	.43	2.14	1.13	3.27
1957.................	.09	.66	-	-	1.16	.40	2.22	1.06	3.28
Marketing:									
1955.................	-	.01	-	-	-	.19	.20	-	.20
1956.................	-	.01	-	-	-	.36	.37	-	.37
1957.................	-	.01	-	-	-	.41	.42	-	.42
Mine products tax:									
1955.................	-	-	-	-	-	.26	.26	-	.26
1956.................	-	-	-	-	-	.34	.34	-	.34
1957.................	-	-	-	-	-	.38	.38	-	.38
General overhead (mine):									
1955.................	.12	1.03	.01	-	.14	.34	1.52	.31	1.83
1956.................	.11	1.05	.01	-	.20	.31	1.57	.33	1.90
1957.................	.13	1.22	.01	-	.29	.56	2.08	.26	4/2.34
General overhead (Manila):									
1955.................	-	.05	-	-	-	.39	.44	-	.44
1956.................	-	-	-	-	-	.46	.46	-	.46
1957.................	-	-	-	-	-	.57	.57	-	.57
Subtotal:									
1955.................	1.23	6.97	1.67	.91	1.85	2.31	13.71	2.42	16.13
1956.................	1.23	7.35	1.78	.86	3.15	2.09	15.23	2.67	17.90
1957.................	1.34	8.29	2.34	1.23	3.91	2.47	18.24	2.83	21.07
Depletion:									
1955.................	-	-	-	-	-	2.34	2.34	-	2.34
1956.................	-	-	-	-	-	2.32	2.32	-	2.32
1957.................	-	-	-	-	-	2.86	2.86	-	2.86
Depreciation:									
1955.................	-	-	-	-	-	2.29	2.29	-	2.29
1956.................	-	-	-	-	-	2.44	2.44	-	2.44
1957.................	-	-	-	-	-	2.17	2.17	-	2.17
Amortization, reorganization expense:									
1955.................	-	-	-	-	-	1.23	1.23	-	1.23
1956.................	-	-	-	-	-	1.23	1.23	-	1.23
1957.................	-	-	-	-	-	-	-	-	-
Other expenses:									
1955.................	-	-	-	-	-	.05	.05	-	.05
1956.................	-	-	-	-	-	.04	.04	-	.04
1957.................	-	-	-	-	-	-	-	-	-
Total:									
1955.................	1.23	6.97	1.67	.91	1.85	8.22	19.62	2.42	22.04
1956.................	1.23	7.35	1.78	.86	3.15	8.12	21.26	2.67	23.93
1957.................	1.34	8.29	2.34	1.23	3.91	7.50	23.27	2.83	26.10

1/ Increased because of 50-percent increase in development footage.

2/ Includes operating development.

3/ Increased because of lower tonnage mined in 1957 and increased labor and supply costs.

4/ This includes distributable expense which increased owing to increased supplies cost.

INT.-BU.OF MINES,PGH.,PA. 218